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STAGE II GASOLINE VAPOR RECOVERY

Proposed Decision, Amendments, and Test Procedure

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[40 CFR Part 52]

[FRL 438-2]

STAGE II GASOLINE VAPOR RECOVERY

Proposed Decision, Amendments, and Test Procedure

This notice announces the Administrator's proposed decision on gasoline station vapor recovery for eight air quality control regions. The current regulations requiring 90 percent recovery of vapors emitted during vehicle refueling did not precisely define the degree of control required nor did they set forth test procedures by which compliance could be determined. The proposed amendments substitute more precise mass emission standards for the percentage requirement and provide test procedures to insure that emission standards will be met by candidate systems. The proposed amendments require that large facilities, which account for 56 percent of the gasoline pumped, and certain new or modified facilities meet an emission limitation of 0.4 gram per gallon of gasoline dispensed. The amendments set a somewhat lenient standard for smaller stations and exempt facilities with very small volumes of gasoline pumped. Finally, the spillage restrictions in the current regulation are being relaxed to a small degree.

In order to allow adequate lead time for further development activities of vapor recovery system manufacturers, plus certification testing of systems, the interim dates in the current regulations are being changed. Control plans from owners of service stations for installation of Stage II systems, involving recovery of vapors from vehicles, will be due December 1, 1976, with final compliance required by May 31, 1977. Manufacturers of systems will have to receive certification of performance capabilities before December 1, 1976, in order for their systems to be available to owners of service stations.

Stage II vapor recovery regulations (as well as several other hydrocarbon control measures) for AQCR's in Texas have been affected by the decision of the United States Court of Appeals in *Texas vs. EPA*, 499 F.2d 289 (Fifth Circuit 1974). Stage II vapor recovery regulations for the affected AQCR's in Texas will be proposed in the revision to the Texas Transportation Control Plan (TCP) and are not part of this proposal.

In a recent decision of the U.S. Court of Appeals for the Fourth Circuit, the Court remanded the vapor recovery regulation in the Baltimore plan to EPA for further consideration in light of EPA's announced intention to provide further guidance as to the devices that will be approved as complying with the regulation. There is no question of the necessity for maximum hydrocarbon control in the Baltimore AQCR, and the guidance regarding vapor recovery devices is contained in today's proposed amendments. Therefore, this notice constitutes a reproposal of the vapor recovery regulation for Baltimore remanded by the Court. The proposed Baltimore regulation will be promulgated along with the amendments to the other plans upon completion of this rulemaking.

Background

In the formulation of Transportation Control Plans in mid-1973, it became evident that in many areas every available hydrocarbon control means had to be implemented if the national ambient air quality standard for oxidants was to be attained by 1977. This meant that stationary sources—representing 25 to 35 percent of hydrocarbon emissions in most areas—had to be controlled along with the motor vehicle. Gasoline marketing controls were incorporated into TCP's because the sources released significant fractions of the AQCR hydrocarbon burden and because control technology was more cost effective than most other available strategies. Current uncontrolled emissions from gasoline transfer operations are about 6 percent of hydrocarbon emissions in typical affected AQCR's. The range of uncontrolled emissions within the eight affected AQCR's is 3 to 16 percent. Two-thirds of these emissions are attributable to terminal operations and filling of storage tanks (Stage I) at service stations while the balance of the uncontrolled emissions emanated from the fueling of automobiles (Stage II). Gasoline marketing emissions are 11 percent of the needed hydrocarbon reduction in a typical AQCR and account for up to 25 percent of stationary source emissions. Uncontrolled emissions from Stage II operations are approximately equivalent to hydrocarbons that will be released from the tailpipes of vehicles meeting 1977 Federal standards. Thus, if gasoline marketing losses were not controlled, they (Stage I, Stage II, and terminals) would become 6 to 30 percent of hydrocarbon emissions in 1985 and eventually would represent tonnages 2 to 4 times greater than motor vehicle exhaust.

In view of this situation, EPA promulgated Transportation Control Plans in 1973 and 1974 which required a 90 percent reduction in gasoline vapors displaced during the filling of storage tanks (Stage I). Similarly, the emissions from fueling of vehicles (Stage II) were also required to be reduced by 90 percent. Implementation of Stage I regulations has moved ahead. The implementation of Stage II regulations, on the other hand, has been delayed by controversies over the effectiveness of control technology and by the need to clarify the intent and degree of control required by the regulation.

The Stage II regulations were incorporated into the Transportation Control Plans for 12 AQCR's including two interstate ACQR's (New Jersey-New York-Connecticut, National Capital) and ten intrastate AQCR's (Baltimore, Boston, Denver, Los Angeles, Sacramento Valley, San Joaquin Valley, Houston-Galveston, Dallas-Fort Worth, San Antonio, and El Paso-Las Cruces-Alamogordo). In addition, similar vehicle fueling regulations were enacted by San Diego County, the San Francisco Bay Area Air Pollution Control District, and the District of Columbia, and are being enacted in Massachusetts and Colorado.

These revisions were prepared in order to more precisely define the degree of control required by Stage II regulations and to provide testing and certification procedures.

Current Control Technology

As the courts have recently stated, Clean Air Act regulations are not necessarily limited to the degree of control achievable with technology already in existence, particularly when section 110 is involved. It is proper and sometimes essential that standards be set which require the development of new technology or improvement of existing technology, along with adequate lead time for the accomplishment of the tasks and sanctions for failure to comply or to contribute to the development of the technology. If technological problems cannot be overcome, the Act provides for extensions upon a showing of adequate efforts by those affected to solve the problems. The overriding consideration in the setting of standards is to be the attainment of the health-based primary ambient air quality standards.

Some of the current "vacuum assist" systems with "secondary recovery" have already shown the potential of attaining emission levels of 0.4 gram per gallon (gpg) (90 percent) in limited field tests. Some of the tests of the "balance" systems have shown the potential of attaining a 0.8 gpg (80 percent) standard. It is expected that manufacturers of these systems will make further improvements and that new concepts or "hybrids" will also come on the scene during the lead time that is being provided.

The balance system depends upon the displacement of air and hydrocarbon vapors as a result of pumping gasoline into the automobile fuel tank. Pressure in the tank created by the incoming fuel forces vapors out to the atmosphere under current, uncontrolled conditions. The concept of the balance system is to provide an alternative route for the vapors—through a vapor return hose to the underground storage tank where it replaces the liquid gasoline which is pumped to the vehicle. Most of the vapor is conserved and converted to liquid product. Potential points of leakage with the balance system are (1) the vehicle vent, (2) the storage tank vent, (3) the automobile fill neck/fill nozzle interface, and (4) any unforeseen leaks in the system. Automobiles produced since 1970 are equipped with carbon canisters which eliminate losses through the vehicle vent. The bulk of hydrocarbon emissions are released at the automobile fill neck and to a lesser degree at the storage tank vent.

The vacuum assist system adds two features to the balance concept; namely, a blower which develops a suction at the nozzle/fill neck interface and a processing unit to recover or otherwise reduce hydrocarbon emissions to the atmosphere. The purpose of the blower is to influence displaced vapors to enter the

vapor return line rather than leak to the atmosphere. The vacuum assist systems depend to some degree on an influx of additional air caused by the "vacuum sweeper" characteristics of the system. (Vapor growth and vapor shrinkage can also be caused in vehicle fueling by differences in temperature and volatility between dispensed gasoline and residual gasoline in the vehicle tank.) The processing unit condenses, absorbs, adsorbs, or incinerates excess hydrocarbon vapors which are not retained in the storage tank. Those systems employing condensation principles conserve most of the vapors and convert them back to liquid product.

Frequently, activated carbon is used to adsorb the vapors and the carbon is regenerated "on-site". One commenter, a manufacturer of activated carbon, has proposed an "off-site" regeneration scheme whereby carbon canisters are replaced periodically and regenerated at a central location. The Administrator has found no clear preference for on-site or off-site regeneration systems. Either approach probably could satisfy the more stringent emission limit of 0.4 gram per gallon if designed and operated properly. Viability in the market place will depend on costs and services offered by vendors of competing technology.

Besides off-site carbon regeneration, a number of firms are attempting to develop and market Stage II control systems which are more effective, less costly, or less complex than existing designs. Some of these processes may be marketed prior to the compliance date and provide significant advantages over existing technology.

Recognizing the many uncertainties regarding the two control technologies, EPA solicited comments on 19 key aspects of Stage II service station control (39 FR 21049, June 18, 1974) and undertook a testing program of both systems. Tests were conducted in San Diego and the San Francisco and Sacramento areas. Comments on the FEDERAL REGISTER notice were received from 42 interested parties. These included 15 petroleum marketers, two marketing trade associations, nine State or local air pollution control agencies, eight vendors of vacuum assist systems and associated products, two manufacturers of vapor balance hardware, two technical societies, two environmental groups, a university professor, and a national testing laboratory. Many of the comments tended to fall into patterns depending upon the commentors' preference for vapor balance or vacuum assist technology. Petroleum marketers and related trade associations recommended the balance system and their comments generally reflected optimism that the system is effective and preferable to blower assist technology. They stated that balance technology is less expensive, simpler, more reliable, safer, almost as effective for hydrocarbon control as blower assist systems, and over the long haul possibly more effective. Comments from vacuum assist vendors and the San Diego County Air Pollution Control District tended to support vacuum assist technology. Advocates of assist technology contend that these systems are much more efficient, able to handle excess vapor conditions, made up of components of proven reliability, safe, and even if more costly than balance systems, still more cost effective than most other strategies to control hydrocarbons. Copies of all comments and additional supporting material are available at EPA's Freedom of Information Office.

In general, estimates of control efficiency of vapor balance systems by their proponents ranged from 81 to 96 percent. However, in many cases supporting data were not provided and in others there were deficiencies in the testing methods such as excluding certain classes of vehicles or failure to measure losses at all possible emission points. Estimates of balance system efficiency by vacuum assist advocates ranged from 20 to 75 percent but no data supporting the lower figures were supplied. In response to a request from San Diego County, and under the direction of an advisory panel, EPA conducted efficiency tests in June 1974 on both balance and vacuum assist systems; in July and August 1974 EPA conducted additional efficiency tests on balance systems in the San Francisco-Sacramento area. These tests showed efficiencies of 69 percent and 83 percent, respectively, for balance systems at two stations in San Diego and efficiencies of 66 percent, 76 percent, 79 percent, and 77 percent for balance systems of four configurations at two stations in the San Francisco and Sacramento areas. The report of the San Diego tests indicates that operator techniques may have some influence on balance system efficiency. The performance standard being proposed for smaller stations would be 0.8 gpg, or about 80 percent.

In general, vacuum assist proponents stated that their systems would provide 90 to 99 percent efficiency, while balance system advocates generally stated that vacuum assists would get 90 percent efficiency. Again, however, the statements were not based on comprehensive testing and the data provided were not conclusive. EPA's 1974 tests in San Diego showed one vacuum assist system with an efficiency of 90 percent; it was not possible to obtain results on two others because of malfunctions which caused leakage. The malfunctions encountered are correctable. In addition, at least two other vacuum assist systems, which are now marketed, were not tested. The performance standards being proposed today for larger stations and for new or modified stations would be 0.4 gpg, or about 90 percent.

Proponents of the balance system stated that their systems were reliable, while vacuum assist systems were unreliable and subject to breakdown so that they would not consistently achieve a 90 percent performance efficiency in actual practice. Vacuum assist advocates, on the other hand, stated that the balance systems could not effectively recover hydrocarbons from many filler neck configurations and needed special handling and techniques unlikely to occur under normal operating conditions, while their own systems used components shown to be reliable elsewhere and required no special operator techniques. EPA has surveyed reliability through a contract study in San Diego in 1974. A further reliability study was initiated in June 1975. Specific reliability, or "down time" problems were identified in 1974 at some vacuum assist service stations. Many of the problems were being corrected by the manufacturers after the survey and none of the reliability problems are considered insurmountable. The proposed test procedure for certification will deal with reliability by (1) requiring that operating conditions during the tests be normal, with special instructions to the operators during the tests prohibited; and (2) requiirng a 30-day "hands-off" reliability period prior to testing.

Advocates of the balance system generally felt that the regulations should exempt vehicles with poorly-mating fill necks and those pre-1970 vehicles with vented fuel tanks. They pointed out that pre-1970 vehicle with vented fuel tanks would not be an important part of the vehicle population in the future. This rationale does not apply to vehicles with poorly-mating fill necks because many vehicles being manufactured today have fill neck configurations with poor zone of access for the collection of displaced vapors. This situaiton cannot be corrected in the immediate future because of lead times necessary to implement design standards. Proponents of vacuum assist systems generally pointed out that the "vacuum sweeper" principle of their system partially overcomes the problem of fill neck configuration, and opposed exemptions. The administrator has concluded that problems of fill neck design should be accounted for in the recovery efficiency requirement rather than by exempting certain vehicles. Not only is this administratively much less burdensome, but it will encourage the development of equipment tion, and opposed exemptions. The Adverse conditions of fill neck design. Such capability will be required over the next 10 years even if regulations for standardized fill necks are promulgated. Therefore, the amendments being proposed today would delete the generally worded exemption in the current regulations.

Balance system proponents claimed that their systems were inherently safe, while vacuum assist systems could pose new hazards in a service station. The vacuum assist advocates argued that the safety arguments had been disproved and that their systems would be as safe as balance systems and an improvement over the uncontrolled service stations' environment. Occupational Safety and Health Administration (OSHA) regulations and the present National Fire Protection Association (NFPA) Flammable and Combustible Liquids Code 30 require listing (review) of service station dispensers and nozzles by a safety testing laboratory. In addition, NFPA has recently drafted Tentative Interim Amendments to Code 30 which establish certain requirements for service station vapor

control systems and require listing of vapor processing systems. Fire marshals may require these or other safety procedures. Safety problems are simply one among the technological problems which the Clean Air Act requires to be overcome through private research and development. EPA will not require the installation of unsafe equipment, but neither will it allow allegations of safety problems to deter the control program and its sanction unless it can be shown that a good faith effort was made to solve the problems and that it could not be done. This question may well be moot since the vacuum assist system of one manufacturer has recently received safety approval from a recognized testing laboratory in California and other manufacturers have submitted their systems to various laboratories for approval. In addition, one vapor balance system nozzle has received approval and other nozzles have been submitted for approval. Issues of safety are properly the province of OSHA and the local fire marshals and nothing in EPA's regulations prohibits them from exercising their authority.

Costs were submitted by several commentators. These commentators included both oil industry representatives and vendors of control equipment. In some instances actual bids were provided and in others only estimates were made available. Direct comparisons of costs for vapor balance and vacuum assist systems were not feasible since none of the commentators provided firm bids for the procurement and installation of both systems at a common facility. Also in most instances, it was not possible to separate Stage I costs from those of Stage II. Common practice was to provide a firm bid for either a balance or assist system and estimate the cost of the other. In some instances, only average costs were submitted.

In general, the vacuum assist proponents indicated that some systems would cost no more than one and one-half times that of a balance system. Advocates of the balance systems, on the other hand, contended that cost differential would be on the order of 2 to 1. Based on information received during the comment period and subsequent submittals, projections were made of the potential capital costs required to purchase and install vapor balance and vacuum assist systems of various designs and configurations currently in use at different size service stations. These projections are as follows:

Station throughput	Vapor balance [1]	Vacuum assist [1]
8,000 gal per mo	$3,000–$5,000	$6,000–$8,000
50,000 gal per mo	6,000–8,000	11,000–15,000
150,000 gal per mo	7,000–10,000	12,000–18,000

[1] Costs include both stage I and stage II equipment.

The projections are expressed as ranges because the costs of installing vapor recovery equipment at individual stations will vary depending upon numerous factors. The higher end of the cost range can be due to a larger number of pumps, pump islands, and storage tanks, unusual site configuration, local labor rates, and the balance system design (manifold or non-manifold) or vacuum assist unit selected. The cost estimates are applicable principally to commercial stations which operate two or more pump islands. Other than commercial stations may have higher or lower costs depending on their particular situation. EPA expects competition, knowledgeable purchasing, and economies of scale to moderate the high ends of the cost ranges. An example of the benefits to be derived from these market forces is found in the case of one San Diego, California, operator of convenience stores. Utilizing competitive procurement procedures for a number of installations, the firm received bids ranging from $3,200 to $7,000 for the installation of vacuum assist equipment at each site, and selected the lowest figure.

One investigation conducted by Agency staff indicates that the cost differential between the two systems may be less than that indicated by the above table in special situations. For example, this study indicated that the comparative cost of equipping a 30,000 gallon a month station with six nozzles may be as follows:

Nonmanifolded balance: [1]	
Drybreaks ($37), caps ($13), ground boxes ($22), and risers ($35) (3 each at $107 per tank)	$321
Cut new openings into tanks (3 at $40 each)	120
Excavation, filling for above (2 person-days, $15/h)	480
Vapor pipes from each dispenser (450 ft times $3/ft)	1,350
Install above (24 h times $20/h, 16 h times $15/h)	480
Trenching, backfill, cementing, et cetera	800
PV valve and vent float valve	35
Nozzles, hoses, flame arrestors (6 at $145 each)	870
Install above (6 at $40 each)	240
Truck, compressor, miscellaneous pipefitting	300
Total	5,236
Manifolded vacuum assist: [1]	
Drybreaks, caps, ground boxes, and risers (3 each at $107 per tank)	321
Cut new openings into tanks (3 at $40 each)	120
Excavation, filling for above (2 person-days, $15/h)	480
Vapor pipes from each island (150 ft times $3/ft)	450
Install above (12 h times $20/h, 8 h times $15/h)	360
Trenching, backfill, cementing, et cetera	535
PV valve and vent float valve	35
Nozzles, hoses, flame arrestors, vacuum regulators (6 at $195 each	1,170
Install above (6 at $60 each)	360
Truck, compressor, miscellaneous pipefitting	200
Vacuum assist unit (list price for single order)	3,000
Alter vents and connect unit	50
Electrical installation	500
Concrete pad	100
Shipping	30
Total	7,771

[1] Costs include both Stage I and Stage II equipment.

These costs are developed from vendor price lists and communications with installers of vapor control equipment.

In order to assure that the Agency can more accurately assess the costs of procuring, installing, and operating the various types of Stage II control equipment, the Administrator is hereby soliciting additional cost information from the general public, oil companies, manufacturers of vapor control equipment, and other governmental regulatory bodies. Responses should be based on actual installations and contain sufficient detail to enable comparative analysis. For example, the station at which the equipment was installed should be identified in terms of number of product tanks, pumps and pump islands, and throughput. Installation costs should be itemized, i.e., excavating, pipe laying, nozzle hookup, and when applicable the installation of vacuum assist components such as ITT valves, flame arrestors, as well as the processing unit. The type of vacuum unit selected, including the throughput rating, or the design of the balance system installed should be specified.

The three-tiered regulation which is being proposed would require the greatest collection efficiency at large facilities which release the largest amount of hydrocarbons. In this respect, the regulation is similar to other stationary source requirements such as process weight regulations for particulates and solvent control regulations applicable to surface coating, drycleaning, and degreasing operations. Facilities constructed or renovated on or after September 1, 1976, would also be required to utilize the most efficient equipment. The proposed regulations do not require control on the large number of existent small stations (less than 120,000 gallons per year) because regulation of such stations would place an extremely heavy testing and surveillance burden on EPA, State and local agencies and industry with a minimal reduction in hydrocarbon emissions.

Description of EPA Abatement Program

In order to assure installation of effective systems, this notice sets forth a proposed test procedure whereby a manufacturer will obtain pre-installation approval of his system. Service station owners and operators will be required to submit, with the control plans currently required by the regulation, evidence of selection of a tested and approved system. In this manner, service station owners will have the option of choosing a vapor collection system with some protection and assurance that the systems will comply with emission standards.

Lead time is being provided for the development over the next several months after which manufacturers will conduct certification tests according to the EPA procedures. EPA reserves the right to observe tests and to conduct tests as deemed necessary. The certification tests are intended to measure expected performance under "real world" conditions. For this reason, various features of the test are designed to prevent the influence of operator bias. These

include the requirement that nozzles not be hand-held and that systems be operated for 30 days without adjustment prior to certification testing.

An application for certification will be required to be accompanied by operating parameters and a maintenance manual. The tests will be conducted according to such parameters and a maintenance manual, and any certification will be given only for systems adhering to such parameters. For example, if a system cannot provide adequate control of vapors and prevent spillage at dispensing rates greater than 6 gallons per minute, it must be designed to limit dispensing rates to that amount. On the other hand, systems which can be shown to perform effectively at higher dispensing rates would not be limited to lesser rates.

The maintenance manual must specify all maintenance necessary to operation of the system. Before granting certification, the Administrator will specify any maintenance procedures which will be added to insure reliable operation. Systems which can only perform successfully under conditions unlikley to be complied with in the field will not be certified.

The certification procedure is designed to stimulate the development of improved technology and to obviate field testing. Owners must submit plans to install certified systems on or before December 1, 1976. Owners who install systems certified by others will be required to demonstrate that their equipment is installed properly and operated in accordance with the regulations.

After the final compliance date, the Agency will conduct field surveys to check to see that control systems are properly installed and being operated in accordance with the operating manual. Critical operating parameters will be checked, and sources whose systems are not meeting their certified efficiency rating will be subject to the sanctions of Section 113. Owners that fail to submit control plans or to install control systems at their facility, or who submit false data will be subject to the penalties enumerated under Section 113 of the Act.

The same procedures will be used to certify systems at both performance levels. Upon evaluating a system, it will be certified for use on all service stations if it limits emissions to 0.4 gram per gallon or less. However, if testing shows that emissions are more than 0.4 but not more than 0.8 gram per gallon, the system will be certified only for stations with throughputs less than 360,000 gallons per year (30,000 gallons per month). It is anticipated that one or more systems employing vacuum assist technology will achieve the required performance levels. The performance of balance systems is less certain. Some data suggests that such systems may not be able to achieve the 0.8 gram per gallon standard. If this should occur, all facilities subject to Stage II controls will be required to install a certified vacuum assist system.

The purpose of this approach is to stimulate the development of new technology. If, for any reason, the deadline were to fall due without a single system having been approved, no extensions in the deadlines for submission of control plans would be given on the mere grounds of unavailability of equipment. Both sections 110(f) and 113(a)(4) of the Clean Air Act provide that extensions are to be available only to those who can show that they have made good faith efforts to comply. Owners of a small number of facilities would be required to show their good faith efforts by their attempts to purchase and install approved recovery systems, while owners of a large number of facilities would be required to demonstrate the extent to which they had encouraged the development of effective systems since 1973, when these regulations were first promulgated, and particularly starting with the publication of this notice. Failure to make an adequate "good faith" showing would render the owner and operator liable to the sanctions available under section 113 of the Clean Air Act.

A good faith effort to develop effective vapor recovery systems will not be shown by attempts to improve only one system. The good faith test requires aggressive investigation and development programs aimed at all possible systems, particularly those which are capable of higher degrees of control, even at higher cost. The Administrator wants to forewarn those subject to this regulation that this position will be taken in any subsequent proceedings which may take place.

Test Methods and Certification Procedures

The proposed test methods pertain to determination of emissions during underground tank filling operations (Stage I) and vehicle refueling operations (Stage II). Stage I methods involve the direct measurement of the volume of air/vapor mixtures emitted to the atmosphere. In contrast, Stage II methods involve indirect measurement because of the difficulty of measuring the various leaks occurring during vehicle fueling. The proposed test method in Section IV of Appendix F was developed and utilized during the test program EPA conducted in San Diego during the summer of 1974. The methods contain a high degree of specificity in terms of test conditions, equipment, and procedures. The purpose of this detail is to insure maximum uniformity in testing and to eliminate oversights and inconsistencies. The detailed procedures are not, however, intended to limit alternative approaches or to otherwise inhibit advances in the state-of-the-art of testing. Therefore, provisions are included for submission of alternative test techniques.

Two alternative Stage II testing techniques have been submitted to EPA for consideration. These techniques are being published in Section V and Section VI of Appendix F for comment. Comments should address the adequacy of procedures for the purpose of measuring emission rates to the atmosphere. Comments and data are also solicited concerning the comparability of the alternatives to the techniques included in Section IV of Appendix F. Based upon these comments and any other information, these techniques may be approved as alternatives to, or may replace respective techniques contained in Section V. Other test methods have also been reviewed prior to this proposal; notably a procedure under development by the State of California Air Resources Board. The latter procedure is not, however, being published for comment because it is similar to the method proposed in Section IV of Appendix F. The methods differ primarily in the technique used for determining baseline emissions.

The indirect Stage II test methods are proposed to be used to measure emissions which occur at the vehicle fill neck/nozzle interface during vehicle refueling. These are being proposed only because no field test method has been shown to be feasible for direct measurement of these emissions. In the case of vapor balance control systems, the quantity of vapor released at the nozzle interface is calculated as the difference between potential emissions and emissions retained in the system. This procedure requires the accurate determination of baseline hydrocarbon emissions from uncontrolled vehicles during each certification test. If it can be shown that baseline emissions can be accurately calculated, the proposed procedure provides for approval of the calculation procedure in lieu of or in combination with baseline testing at the facility. Comments and data are invited on the development and possible use of a single baseline for all testing of all vapor balance control systems.

For vacuum assist Stage II control systems, an empirical procedure is proposed to supplement a direct measurement technique. This procedure is based upon data measured during EPA-sponsored tests in San Diego, California, in 1974. Here it was found that when there were no leaks at the nozzle/fill neck interface, hydrocarbon concentrations as measured with a portable detector did not exceed 10 percent of the lower explosive limit (LEL), i.e., about 0.2 percent hydrocarbons by volume. When hydrocarbon concentrations exceeded 1.0 LEL, the average collection efficiency of balance systems was found to be approximately 44 percent. Measurements in all cases were conducted in immediate proximity of the fill neck/nozzle interface. These data were used to develop an empirical relationship between vapor losses at the nozzle interface and explosimeter readings. These losses will be added to losses measured directly in the exhaust stream. This empirical procedure will have little importance for fully effective vacuum assist systems since there should be few measurable leaks at the nozzle interface. Nevertheless, the procedure will assure that significant leakage is not overlooked. The procedure is unnecessary for balance systems since the aforementioned indirect procedure measures nozzle interface losses. Comments and data are also invited on alternative test procedures for vacuum assist control systems, including the possibility of utilizing a baseline approach

similar to the proposed vapor balance control system test procedure.

The proposed Stage II test procedures use only vehicles which are filled with automatic dispensing nozzles operating in a "hands-off" condition. This is typical of most normal operations at a filling station although some hand-held filling does occur. Typical hand-held operation cannot be duplicated during a certification test. Therefore, to insure that operator bias will not unnecessarily influence test results, hand-held operations are not included in the emission calculations. However, there is a growing trend toward self-service operations in gasoline retailing. Because self-service operation is likely to affect the recovery efficiency of the systems, this mode of operation should be incorporated in the test methods in some manner to provide a realistic measure of the effectiveness of the system under normal operating conditions. Comments and data are invited on the effect of self-service operations on the recovery of various systems, and how these operations could be simulated by or incorporated into any certification test procedures.

The cost for testing control systems is high, ranging from approximately $4,000 for individual vacuum assist installations to upwards of $10,000 for individual vapor balance installations. In light of the testing costs associated with individual installations, procedures are being proposed for approval of systems based upon testing of representative models. Costs associated with certification of a system design in accordance with these procedures may range from $10,000 to $50,000. Since the number of balance system designs is estimated at 5 or 6 and assist systems at 8 to 10, the overall cost of determining compliance will, although substantial, be small compared to the cost of the control systems required by this regulation. As proposed, the test procedures applicable to testing representative models include only a general requirement that the distribution or mix of test vehicles shall be reasonably representative of the on-the-road vehicle distribution in the United States. It is EPA's intent, if possible, to make this requirement more specific, particularly with respect to the distribution of vehicles for which fill neck characteristics affect collection efficiency. Toward this end, a survey has been initiated to obtain data which can be used to characterize the distribution of various fill neck sizes and configurations more precisely. The intent of the proposed requirement and of the current survey is to insure that test results are not biased by an abnormal distribution of test vehicles.

Spillage Restrictions

Besides displacement vapor losses, vehicle fueling operations result in spillage of liquid gasoline on exposed surfaces with resultant evaporation of hydrocarbons to the atmosphere. Spillage losses at uncontrolled stations average about 0.3 gram per gallon of gasoline dispensed. Current regulations, e.g., § 52.1599(a)(3) for New Jersey prohibit all fuel tank overfills or spillage on fill nozzle disconnect. In EPA's test program it was found that there were no systems which would completely eliminate spillage. In testing four balance systems, a total of 697 vehicle fillings resulted in 28 cases of spillage.[1-2] This is a rate of four spills for every 100 fills. Three vacuum assist systems gave a higher spillage rate (18 per 100 fills) but EPA believes that this rate can be reduced through design modifications or reducing fill rate.[1] Therefore, the spillage requirement is being relaxed only to a small degree allowing five spills per 100 fills. Assuming that an average of 12 gallons is dispensed per fill and that the average spill is 10.5 grams,[11] allowable spillage would represent a loss of 0.05 gram per gallon of gasoline dispensed.

Responsibility of Owners and Operators

In the notice of June 18, 1974, EPA requested comments on whether the owner/lessor or the operator of a leased facility subject to Stage II vapor recovery regulations should be the party required to install the equipment. Eighteen organizations and individuals presented comments. Thirteen parties, including oil companies, pollution control equipment manufacturers, State and local air pollution control boards, an environmental group, and a State association of gasoline retailers favored a requirement that the owner/lessor be responsible for installation of the equipment. In general, these comments stated that the installation should be the responsibility of the party who owns the underground storage tanks and dispensing pumps because vapor recovery equipment is a permanent addition to such equipment.

Four organizations commenting proposed that the responsible party be determined by individual contractual provisions or past customs on similar matters. They pointed to many different and complex contractual relationships in the industry and stated that a uniform requirement would be undesirable.

The proposed regulations adopt the first view that the owner of the underground storage tanks and dispensing pumps should be responsible for submitting a control plan and installing the vapor recovery system. The owner has the permanent interest and exercises control over the relevant equipment. As owner he is also responsible under the regulations for providing maintenance instructions on the vapor recovery system installed to the operator and for repair or replacement of major system components (e.g., blowers, secondary recovery units), upon notice by the operator that such maintenance is needed. The owner is also required to keep records of the maintenance of major components for which he is responsible under the regulations.

The operator of the facility is responsible under the proposed regulations for day-to-day operation and maintenance of the vapor recovery system according to the instructions provided by the owner and for notifying the owner of the need for replacement or repair of major system components. Records of all maintenance performed must be kept by the operator, whether the maintenance is performed by the operator or by the owner or his agent upon notice by the operator. The operator is also required to maintain gauges, meters, or other specified field testing devices in proper working order.

Under the proposed regulations, both the owner and the operator are subject to the prohibition against transferring gasoline to motor vehicles at facilities subject to the regulation unless the facility is equipped with a system which will meet the vapor emission standards applicable to the facility.

Fill Pipe Standardization

Variations in vehicle fill pipe configurations represent the most significant problem in controlling hydrocarbon emissions during automobile refueling. Developers of control systems have sought to overcome this problem by various means. To date, however, the various systems offered have not been able to uniformly maintain the same efficiency for all vehicle fill pipe configurations encountered. Sensitivity of system efficiency to vehicle mix and the related factor of operator technique could be greatly reduced or eliminated if vehicle fill pipes were standardized. The associated problem of fuel spillage could also be remedied. Unless fill pipes are standardized there will be nothing to prevent detrimental changes to fill pipe designs which could eventually invalidate vapor recovery certification tests.

In view of this situation, the agency is presently studying the possibility of fill pipe standardization. Standard specifications might include limits on fill pipe diameter; minimum design criteria for nozzle retainer lips; limits on the location of the unleaded fuel restrictors; a minimum access zone surrounding the fill pipe; and a minimum fill pipe or nozzle insertion angle.

However, considering the lead time needed for development and implementation of any standard specification for fill pipes (1–3 years) and the time needed for standardized vehicles to replace the on-the-road vehicle population (10 years), fuel pipe standardization must be viewed as a long-term aspect of the refueling emission control program. Therefore, owners of facilities subject to Stage II gasoline marketing regulations should not rely upon fuel pipe standardization when developing or procuring control systems for the purpose of complying with these regulations by May 1977.

Public Comments

This notice consists of a proposed decision on amendments to existing Stage II regulations and sets forth testing and certification procedures. This decision will be finalized as quickly as possible. These proposed amendments are being published as one complete regulation. This format is being used to make for better reading and clearer comprehension of the proposed amendments. It is the intent of this proposal to clearly explain and describe the impact of these proposed amendments and to obtain pertinent public comments before final rulemaking. For final rulemaking, the

amendments will be published in accordance with formal FEDERAL REGISTER requirements so that each of the existing state Stage II regulations will be amended by the corresponding paragraphs of the regulation presently being proposed.

The record and basis for the Agency's decision consists of the public comments made in response to the June 18, 1974, FEDERAL REGISTER notice, as well as certain other documents listed at the end of this notice. The submission have been available for public inspection since August 1974, at EPA's Freedom of Information Office, as announced in the June 18, 1974, FEDERAL REGISTER. Persons who believe that this final proposal improperly fails to deal with comments or information previously submitted or available should call this to the Administrator's attention at this time.

Comments on the proposed revisions should be submitted, preferably in triplicate, to Mr. Roger Strelow, Office of Air and Waste Management, U.S. Environmental Protection Agency, 401 M Street, S.W., Washington, D.C. 20460. All comments postmarked not later than November 24, 1975, will be considered.

(Sections 110(c) and 301 of the Clean Air Act, 42 U.S.C. § 1857c-5(c) and § 1857g)

Dated: October 1, 1975.

JOHN QUARLES,
Acting Administrator.

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17. Liston, E. M., Evaluation of the Baseline Procedure for Determining the Efficiency of a Simple Displacement System for Vapor Recovery at Service Stations. Prepared by Stanford Research Institute for American Petroleum Institute, January 1975.

18. Panarisi, F., Gasoline Vapor Recovery Test Results, Report to the San Diego County Board of Supervisors, August 14, 1974.

19. Goeller, B. F. et al, San Diego Clean Air Project: Summary Report. Prepared by the Rand Corporation for the County of San Diego, December 1973.

It is proposed to amend Part 52 of Chapter I, Title 40 of the Code of Federal Regulations. The following subparts and sections would be amended by this proposal:

1. Subpart F—§ 52.256 Control of evaporative losses from the filling of vehicular tanks. (Metropolitan Los Angeles, Sacramento Valley, and San Joaquin Valley Intrastate Air Quality Control Regions.)

2. Subpart G—§ 52.337 Control of evaporative losses from the filling of vehicular tanks. (Metropolitan Denver Intrastate Air Quality Control Region.)

3. Subpart J—§ 52.488 Control of evaporative losses from the filling of vehicular tanks. (District of Columbia portion of the National Capital Interstate Air Quality Control Region.)

4. Subpart V—§ 52.1087 Control of evaporative losses from the filling of vehicular tanks. (Maryland portion of the National Capital Interstate Air Quality Control Region.)

5. Subpart V—§ 52.1102 Control of evaporative losses from the filling of vehicular tanks. (Metropolitan Baltimore Intrastate Air Quality Control Region.)

6. Subpart VV—§ 52.2438 Control of evaporative losses from the filling of vehicular tanks. (Virginia portion of the National Capital Interstate Air Quality Control Region.)

7. Subpart W—§ 52.1144 Control of evaporative emissions from retail gasoline outlets. Section (d). (Metropolitan Boston Intrastate Air Quality Control Region.)

8. Subpart FF—§ 52.1599 Control of evaporative losses from the filling of vehicular tanks. (New Jersey portion of the New Jersey-New York-Connecticut Air Quality Control Region.)

1. It is proposed to revise each of these sections in Part 52 by substituting the following provision:

§ 52 Control of evaporative losses from the filling of vehicular tanks.

(a) Definitions:

(1) "Gasoline" means any petroleum distillate having a Reid Vapor Pressure of 4 pounds or greater.

(2) "Facility" means any site where gasoline is dispensed to vehicle fuel tanks from any stationary storage container with a capacity greater than 250 gallons, except that the term does not include any such site where the stationary storage container capacity does not exceed 550 gallons and the gasoline is dispensed exclusively for the fueling of implements of husbandry.

(3) "Group A" means any facility which dispenses 360,000 gallons or more of gasoline during a representative year from stationary tanks through dispensing equipment to vehicle fuel tanks or any gasoline dispensing facility, the construction or modification of which is commenced on or after September 1, 1976.

(4) "Group B" means any facility which dispenses 120,000 gallons or more but less than 360,000 gallons of gasoline during a representative year from stationary tanks through dispensing equipment to vehicle fuel tanks.

(5) "Group C" means any existing facility which dispenses less than 120,000 gallons of gasoline during a representative year from stationary tanks through dispensing equipment to vehicle fuel tanks. Such a facility is not required by this regulation to install or operate Stage II vapor recovery equipment.

(6) "Representative year" for a facility means calendar year 1975, unless the owner of the facility shows that gasoline sales for 1977 or later years are likely to be substantially different from 1975 sales.

(7) "Commence construction" means to engage in a continuous program of construction including site clearance, grading, dredging, or land filling specifically designed for a facility in preparation for the fabrication, erection, or installation of the building or equipment components of the facility.

(8) "Commence modification" means to engage in a continuous program of modification, including site clearance, grading, dredging, or land filling in preparation for a specific modification of the facility.

(9) "Modification" means any renovation of a facility which increases the gasoline storage capacity of an underground tank at the facility or increases the number of gasoline pumps at the facility.

(10) "Owner" means any person who has legal title to the stationary gasoline storage tank(s) and gasoline dispensing equipment at a facility which dispenses gasoline to vehicle fuel tanks.

(11) "Operator" means any person who leases, operates, or supervises a facility at which gasoline is dispensed from stationary storage tanks through dispensing equipment to vehicle fuel tanks.

(b) No owner or operator shall transfer or allow the transfer of gasoline to a motor vehicle fuel tank from a gasoline dispensing facility unless the transfer is made through a system which:

(1) When tested according to the procedures in Appendix F limits the discharge of hydrocarbons into the atmosphere as a result of the refueling operation to:

(i) 0.40 gram of hydrocarbon vapor per gallon of fuel dispensed at Group A facilities.

(ii) 0.80 gram of hydrocarbon vapor per gallon of fuel dispensed at Group B facilities.

(2) Allows motor vehicle fuel tank overfills or spillage in no more than five vehicle fillings in 100 or fewer consecutive fillings.

(c) Every owner of a Group A or Group B facility subject to the requirements of this regulation shall:

(1) Submit to the Administrator no later than December 1, 1976, a control plan applicable to each facility which includes:

(i) A signed commitment to install a control system which has been certified by EPA prior to the date for submission of this control plan in accordance with procedures specified in Appendix F. This control plan shall include:

(*a*) A description of the control system including make, model, size, required field testing devices, and other pertinent features.

(*b*) The address(es) of each facility covered by this control plan.

(*c*) The calendar year 1975 throughput for each facility covered by this control plan. In lieu of the exact 1975 throughput, the group designation for each facility covered by this control plan may be substituted. Any projected increase or decrease in gasoline sales at a facility due to closing, renovation, or expansion that would cause the facility to change to a group subject to different emission standards before January 1, 1977, shall be reported in the control plan.

(2) Complete installation of a system which complies with the provisions of paragraph (b) of this section no later than May 31, 1977.

(3) Provide to the operator the specifications, operating and maintenance procedures specified by the manufacturer of the control system and approved by the Administrator pursuant to the certification procedures in Appendix F, and provide procedures for prompt notification of the owner by the operator of any scheduled maintenance or malfunction requiring replacement or repair of major components of the system.

(4) Repair or replace any major components of the system promptly after notice by the operator that such components require such maintenance.

(5) Maintain records of any notification by the operator of any scheduled maintenance or malfunction requiring replacement or repair of major components of the system and the action taken. These records shall include the date and description of the maintenance performed, the date the need for maintenance or the malfunction was reported, and the date the maintenance was performed or the malfunction was corrected. These records shall be preserved for not less than one year for each facility and shall be available for inspection by authorized EPA personnel.

(d) Every operator of a Group A or Group B facility subject to the requirements of this regulation shall:

(1) Maintain and operate the control system in accordance with specifications, operating and maintenance procedures specified by the manufacturer of the control system and approved by the Administrator pursuant to the certification procedures in Appendix F.

(2) Notify the owner of the facility of any scheduled maintenance or malfunction requiring replacement or repair of major components of the system.

(3) Maintain records of all maintenance performed by the operator and any notification to the owner of any scheduled maintenance or malfunction requiring replacement or repair of major components of the system and the action taken by him. These records shall include the date and description of the maintenance performed, the date the need for maintenance or malfunction of major system components was reported to the owner, and the date the maintenance was performed or the malfunction was corrected by either the operator or the owner.

(4) Maintain gauges, meters, or other specified testing devices in proper working order and to provide access to these devices to authorized EPA personnel.

(e) Nothing in this paragraph shall preclude the Administrator from promulgating a separate schedule for any source to which the application of a compliance schedule in paragraph (c) of this section fails to satisfy the requirements of § 51.15 (b) and (c) of this chapter.

(f) Any owner or operator of a gasoline dispensing facility subject to this regulation which installs a gasoline dispensing system after the effective date of this regulation and before May 31, 1977, shall comply with the requirements of this section by May 31, 1977. Any owner or operator of a facility subject to this regulation which installs a gasoline dispensing system after May 31, 1977, shall comply with the requirements of this section at the time of installation.

2. Appendix F, Parts I through VI are added as follows:

APPENDIX F—PROCEDURES FOR OBTAINING APPROVAL OF SYSTEMS FOR CONTROLLING GASOLINE VAPOR EMISSIONS AT SERVICE STATIONS

This appendix sets forth general requirements, procedures, and test methods to be followed for the purpose of obtaining approval of service station vapor control systems. Two procedures are described: (1) a procedure to be followed to demonstrate compliance and obtain approval of a control system at an individual installation; and (2) a procedure to be followed to demonstrate the compliance capability and obtain approval of a control system of a specified design. The latter procedure involves testing one or more representative model. The results of such testing are applicable for determining the compliance capability and for obtaining approval of similar untested models.

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VI. Tentative alternate procedure for measuring volume of hydrocarbon vapors during vehicle refueling operations with vapor balance control systems

I. GENERAL REQUIREMENTS APPLICABLE TO CERTIFICATION OF ALL CONTROL SYSTEMS

1.1 Operating and Required Maintenance Manual. An operating and required maintenance manual shall be produced for each gasoline vapor control system approved pursuant to this appendix. The operating manual shall conform to the following and as a minimum contain the following information and data:

1.1.1 Identification of critical operating parameters affecting system operation (e.g., maximum dispensing rates; liquid to vapor flow rate ratios; pressures; exhaust concentrations; etc.). The operating range of these parameters associated with normal, in-compliance operation of the control system, shall be identified in the manual. These operating data shall be determined and/or verified during the performance test of the system. The Administrator reserves the right to designate critical operating parameters.

1.1.2 Identification of specific maintenance requirements and maintenance schedules necessary to insure on-going operation in compliance with the applicable standards. Maintenance requirements shall be clearly identified as being capable of performance by the operator, or as requiring authorized service only. Operating manuals shall provide clear instruction on how to perform operator maintenance and shall provide clear warnings against providing unauthorized service. Maintenance schedules shall be reasonable and at a minimum, reflect the rated life of individual components such as regulators, compressors, nozzles, pressure vacuum valves, catalysts, combustor components, etc. The reasonableness of maintenance schedules will be evaluated in terms of whether service station personnel could be reasonably expected to perform the required maintenance on the indicated schedule. Systems requiring unreasonable maintenance will be disapproved.

1.1.3 Identification of system components shall be included for each control system approved pursuant to Section III of this Appendix. Components shall, as applicable, be

identified by brand name, part number, and/or performance characteristics. The identification shall be sufficiently clear so as to allow determination of comparability between tested and untested models, and/or to allow determination of the adequacy of replacement parts.

1.2 Indicating Gauges and Alarms. Indicating gauges, alarms and/or detection devices shall be included in each control system approved pursuant to this Appendix. Such gauges and alarms shall, as applicable, include temperature and pressure indicators, pass/fail hydrocarbon detectors, etc. These shall be installed so as to indicate the performance of critical components such as compressors, carbon canisters, etc. The Administrator reserves the right to specify such devices which are considered necessary. Specific examples of necessary devices are: temperature indicators installed in control systems which utilize refrigeration as a control technique; pressure indicators installed in control systems which utilize compression as a control technique; hydrocarbon breakthrough detectors installed in control systems which utilize carbon adsorption or flexible bladders or seals as a control technique.

1.3 Testing Methods. Tests conducted for the purpose of obtaining approval of a control system shall be performed according to the applicable test methods set forth in Section IV of this Appendix or alternative test methods approved by the Administrator. Any such test shall be preceded by 30 days of normal operation of the gasoline service station with the control system in operation. During this thirty-day period, no maintenance, adjustment, replacement of components or other such alteration of the control system is allowed unless such action is specifically called for in the maintenance manual at respective intervals of less than 30 days. Any such alteration shall be recorded on the day on which the alteration was performed. This requirement for 30 days of unattended operation is intended as a demonstration of the minimum reliability of the control system. Failure to meet this requirement will be considered a failure to pass the performance test.

1.4 Notification. Any owner, operator, or vendor planning to conduct a test in accordance with paragraph 1.3 shall notify the Administrator 45 days in advance of any such test (15 days in advance of the pre-test operating period). The notification shall be accompanied by the submittal of an operating manual meeting the requirements of paragraph 1.1 of this Section. The system to be tested shall conform to the manual, and shall be equipped with appropriate indicating gauges and alarms as required in paragraph 1.2 of this Section. Testing conducted without prior notification as outlined in this paragraph, or testing of systems which do not conform to the submitted description may be considered as a basis for rejection of the test results.

1.5 Submittal of Results. Test results shall be submitted to the Administrator after completion of the performance test. These results shall include:

1.5.1 A record of any maintenance, adjustment, component replacement or other such alteration of the control system, made during the performance test or the 30 days preceding the test.

1.5.2 Copies of all field data sheets.

1.5.3 A description of any deviation from the prescribed test procedure.

1.5.4 An example calculation using actual data from the test.

1.5.5 Complete test results including, as appropriate, calculated calibration curves, potential emission curves, etc., and final results. Final results shall be expressed in terms of the applicable emission limitations and shall include operations over the entire test period. If certain vehicles were rejected from the calculation or if data was not obtained or used during any portion of the test period, this should be clearly noted along with appropriate explanation. When more than one test is conducted, pursuant to Section III of this Appendix, the mean results (weighted on a per vehicle basis) shall be calculated in terms of the applicable emission limitations. The mean results shall be used as a basis for determining the approvability of the control system.

1.6 EPA testing and right of entry. EPA reserves the right to conduct certification testing of systems at the location specified in the notification in Section 1.4. Notice of EPA's intention to conduct certification testing shall be provided within 14 days of receipt of the notification of intent to test. Whether EPA chooses to conduct the certification testing, or allows the system proponent to conduct the certification testing, the owner, operator, lessee, or vendor shall allow EPA representatives on the premises specified in the notification at any time during the thirty day pre-test operation period or the certification testing. Failure to allow EPA to conduct the testing or failure to allow EPA representatives on the premises during the thirty day pre-test operation period or actual testing period shall result in failure of the system to be certified.

1.7 Retesting of systems failing to meet performance criteria. Control systems which fail to meet performance criteria for applicable gallonage levels shall be allowed to be retested on the following basis:

(a) Any system which fails to meet applicable emission criteria will be allowed to retest only if the result of the initial testing and any subsequent testing are combined. The mean results of all testing (weighted on a per vehicle basis) shall be calculated in terms of the applicable emission limitations.

(b) Systems may be allowed to retest and discard initial test results only if such initial tests were invalid or if significant and substantial modifications are made to the control system. The Administrator shall make such determinations.

II. Procedures Applicable to Testing and Approval of Control Systems at Individual Installations

2.1 Testing Requirements. Any owner, operator, or vendor electing to demonstrate compliance and obtain approval of a control system at an individual installation shall conduct a performance test of the control system installed at that installation.

2.2 Throughput Requirements. During the period of any performance test performed pursuant to paragraph 2.1, the service station should be operating at 75% or more of the maximum daily throughput. If this throughput is not attained, and engineering evaluation cannot demonstrate the control system to be capable of attaining compliance at higher throughput, the system will not be approved for higher throughput.

III. Procedures for Demonstrating Compliance of Similar Systems by Testing Representative Models

3.1 Testing Requirements. An owner or operator electing to demonstrate the compliance capability and obtain approval of a product line or group of control systems of similar design shall conduct performance tests on five representative models. Alternatively the Administrator will consider other tests and/or engineering data submitted for the purpose of demonstrating compliance capability. As a minimum, one representative model shall be tested.

3.2 Throughput Requirements. EPA approval pursuant to testing according to this Section will be based upon the maximum daily throughput at which the systems have been tested. The approval will not be applicable for higher throughput unless it can be demonstrated through engineering evaluation and/or other data that the system is capable of complying under conditions of higher throughput.

3.3 Approval of Similar Systems for Greater or Less Capacity. For systems which are identical in design and include similar components to systems tested and approved pursuant to subparagraph 3.2, but differ, primarily in size, the owner or vendor may demonstrate compliance capability and obtain approval by submitting engineering and/or test data demonstrating the relationship between capacity and throughput of each component whose performance is a function of throughput. Examples of such components include: blowers, catalyst, carbon or other adsorbant, compressors, heat exchangers, combustors, piping, etc. As practical, test data should cover a range which will allow assessment of size/capacity relationships based on interpolation; extrapolation should be avoided. EPA will consider such data and may on the basis of these data, approve models which involve similar designs and components, but which differ in size and capacity from those tested.

IV. Field Test Procedures for Stage I and Stage II Control Systems

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1. *Principal.*

Hydrocarbon mass emissions are determined directly and indirectly using flow meters and hydrocarbon analyzers. The volume of liquid gasoline dispensed (or transferred to the underground tank) is determined. Results are expressed in terms of grams emitted per gallon dispensed (or control efficiency for underground tank fillings).

2. *Applicability.*

This method is applicable to determining emission rates during normal operation of gasoline service stations employing vapor balance or vacuum assist type of control systems. The method is applicable to both vehicle refueling and underground tank filling operations at service stations employing either type of control systems.

3. *Definitions.*

3.1 Potential emissions. As used in this method, the term "potential emissions" means the vapor emissions which would be returned to the underground tank during stage II refueling operations employing vapor balance equipment, when no vapor escapes to the atmosphere from the vehicle tank or the nozzle/fillneck interface.

3.2 Vapor balance or displacement vapor recovery system. A gasoline vapor control system which uses direct displacement to force vapors into the underground tank (or bulk delivery tank) or otherwise prevent the emission or displaced vapors to the atmosphere during stage I and/or stage II operations.

3.3 Vacuum assisted or secondary system. A gasoline vapor control system which employs a pump, blower, or other vacuum inducing device to collect and/or process vapors generated during stage II and/or stage II operations.

3.4 Stage I. Underground tank refilling operations.

3.5 Stage II. Vehicle refueling operations.

3.6 Automatic Nozzle. A nozzle which is capable of dispensing fuel without being hand held.

4. *Summary of the Methods.*

This procedure describes test conditions and test procedures to be followed in determining hydrocarbon emission rates from vapor balance and vacuum assisted systems installed to control emissions resulting from vehicle refueling operations and from underground tank refilling operations. Four procedures are included applicable to the four respectively noted systems and operations. A summary of each procedure is provided in the following paragraphs.

4.1 Stage I operations at vapor balance systems. Direct measurements of vent losses are made for determination of emission losses and system efficiency of vapor balance collection systems during bulk deliveries to gasoline service stations. The volume of vapors exhausted to the atmosphere during a bulk delivery are measured. Control efficiency is determined from the ratio of volume emitted (corrected to the temperature of the underground tank) divided by the volume of gasoline delivered.

4.2 Stage II operations at vapor balance systems. This procedure is performed during normal operation of the service station. Under the procedure hydrocarbon losses at the vehicle are determined indirectly by measuring the mass of hydrocarbons collected at the vehicle and comparing that mass with potential mass emissions calculated for that vehicle. The difference between the potential mass emissions and the mass actually collected is considered to be the mass emitted to the atmosphere at the vehicle. Potential mass emissions are determined by measuring the mass of hydrocarbon collected during the refueling of vehicles from which no leaks occurred during refueling. Potential emissions are expressed as a function of the difference between the dispensed gasoline temperature and the temperature of the gasoline in the vehicle tank. In addition to losses at the vehicle, hydrocarbon losses from the underground tank are determined by direct measurement. Total mass emissions are determined by adding the losses to the atmosphere occurring at the vehicle to the losses occurring from the underground tank vent.

Alternately, potential emissions may be determined from empirical or theoretically derived equations and may be used to calculate a baseline if, and at such time that equations become available and are verified as to accuracy. Results are expressed as mass of hydrocarbons emitted per unit volume of fuel dispensed.

4.3 Stage I operations at vacuum assisted systems. Direct measurements of volume and hydrocarbon concentration of exhaust gases are made in order to determine efficiency of the secondary system to control vapors lost during bulk gasoline deliveries. All possible points of emissions are checked for vapor leaks and estimates or direct measurements of leaks are made and are included in the emission calculations.

4.4 Stage II operations at vacuum assisted systems. Emissions are determined by direct measurement during normal operation of the service station. Hydrocarbon mass emitted from the exhaust of the secondary control device is measured. All points of possible emissions are checked for vapor leaks and estimates or direct measurements of leaks are made. These vapor losses are added to the emissions from the secondary control device and are included in calculating total emission. Results are expressed in terms of mass of hydrocarbons emitted per unit volume of gasoline dispensed from the system. The method includes a mass balance procedure to verify that any leaks are taken into account. A mass balance calculation showing unaccounted vapor losses voids the emission test.

5. *Test Scope and Conditions Applicable to Stage II Testing.*

5.1 Test Period. The elapsed time during which the test is performed shall not be less than three days.

5.2 Number of vehicles to be tested.

5.2.1 Vapor Balance Systems. A minimum of 100 vehicles shall be refueled at pumps being used to perform tests according to the procedures of Section 7.1. At least 20 leak-free fillings shall be made in accordance with the procedures of subsection 7.2.3. Potential emissions from a vehicle may vary as a function of volume of fuel delivered per available fuel tank capacity. It is suggested, therefore, that only vehicles receiving more than minimum delivery of gasoline (more than 10 gallons or more than one-half tank, whichever is less, or a fill-up) be included in the test data. Any such rejection criteria shall be established prior to the test.

5.2.2 Vacuum Assist Systems. A minimum of 100 vehicles shall be refueled at pumps being monitored according to the procedures 7.4.2.

5.3 Station status during test period. The test procedure is designed to measure control efficiency under conditions of normal operation. Normal operation will vary from station to station and from day to day. Therefore, no specific criteria are set forth to define normal operation. The following guidelines are provided to assist in determining normal operation.

5.3.1 Closing of pumps. During the test period, at least two pumps shall be open and utilized on each product line which is controlled by the device or is interconnected into the system under test. If product lines involve no interconnection of liquid or vapor lines and do not share control equipment, the product line not being tested may be closed.

5.3.2 Acceptance of vehicles. During the test period, no vehicle arriving for the purpose of refueling from the product under test shall be turned away. No other measures shall be employed which would limit the number of vehicles which would normally be served on a daily basis, from the product line under test.

5.3.3 Simultaneous use of more than one pump shall occur to the extent that such use would normally occur.

5.3.4 Dispensing rates shall be set at the maximum rate at which the equipment is designed to be operated. This maximum rate shall be used during refueling. Where fillneck configuration prevents filling at maximum rate, fill rates may be limited according to normal procedures.

5.3.5 Where automatic nozzles are employed, filling shall be accomplished "hands off." Only such "hands off" fillings shall be considered valid for the purposes of this method. Where this is not possible, hand held operation is acceptable. Included in such situations is the case where the dispensing nozzle would fall out of the vehicle fillneck if not hand held in place. Such "hand held" fillings shall not be included in the calculations under this method.

5.4 Distribution of vehicles by make and model. The distribution of vehicles refueled during the test period at any single station is not required to conform within any specified limits unless the test results are intended to be used as an example to demonstrate conformance at other untested stations. In such case the vehicle distribution should be reasonably representative of the U.S. on the road vehicle distribution. Specific consideration should be given to vehicle make and to the ratio of pre-1971 versus post 1970 vehicles (pre-1970 versus post 1969 in California).

In order to conform to such distribution, as necessary, proration of the vehicles tested in each class may be made. The purpose of such proration would be to bring the tested distribution into conformance with the actual U.S. vehicle distribution.

5.5 Ambient temperature. Tests of vehicle refueling emissions are not required on any day during which the maximum one hour temperature does not exceed 65° F. If this temperature is not attained on any test day, the test results for that day may be disregarded. In such case an additional day of valid results shall be obtained. If the ambient temperature during the day of testing exceeds 85°F, only those results of tests conducted prior to the hour 85°F is reached shall be considered valid.

5.6 Dispensed fuel RVP. The RVP of the fuel dispensed during the test shall be within the range which is normal for the geographic location and time of year of the test, but in no case shall be less than 8.5 RVP.

6. *Basic Measurements and Equipment Required.*

6.1 Stage I. Operations at vapor balance systems.

6.1.1 Basic measurements required—The sampling points are numbered and shown in Figure 1. Some measurements are noted as optional. These are not necessary in the determination of emission rate, but can assist in evaluating the performance of the vapor recovery system.

Sample point	*Measurements necessary*
1 (vent outlet for underground tank).	Volume of vapors exhausted.
2 (underground tank)-----	Temperature of liquid. Volume of liquid.
3 (bulk delivery tank)-----	Temperature of liquid (optional). Pressure in tank (optional). Check for hydrocarbon leaks at all connections.

6.1.3 The equipment required for the basic measurements are listed below. Alternative equipment may be used subject to the approval by the Administrator.

Sample point	*Equipment and specifications*
1	1 dry gas volume meter (3 cfm).
2	1 flexible thermocouple with readout (range 0–100°F).
3	1 flexible thermocouple with readout (range 0–100°F).
	1 0–10" H_2O manometer.
	1 portable combustible gas detector (at least 0–100% lower explosive limit range).

6.2 State II operations at vapor balance systems.

6.2.1 Basic measurements required are described below. Some measurements are noted as optional. These are not necessary in the determination of emission rate, but can be of value in the description and explanation of the operation of the vapor recovery system. Referring to Figure 1, the various sampling points in the system are numbered.

Sample point	*Measurements necessary*
4 (dispensing nozzle and vehicle fillneck).	Check for gasoline vapor leaks around nozzle-fillneck interface during refueling.
	Temperature of vehicle tank gasoline prior to refueling.
	Hydrocarbon concentration of returned vapors.
	Temperature of returned vapors during refueling (optional).
	Temperature of dispensed gasoline during refueling.
	Leak check after refueling.
5 (vapor return hose)	Volume of gasoline vapors returned.
	Pressure in vapor return line (optional).
6 (gasoline meter and pump).	Volume of gasoline dispensed for each vehicle.
	Volume of gasoline dispensed during test period.
1 (vent outlet for underground tank).	Volume of vapors exhausted via solenoid valve device (Figure 3).
	Hydrocarbon concentration of exhausted vapors.
2 (underground tank)	Temperature of liquid in underground tank (optional).
	Volume of liquid.
	Sample for Reid vapor pressure analysis.

6.2.2 The equipment required for the basic measurements are listed below. Alternative equipment may be used subject to approval of the Administrator.

Sample point	*Equipment and specifications*
4[1]	1 portable combustible gas detector (at least 0–100% of lower explosive limit range).
	3 flexible thermocouples (range 0–105°F) and recorders.
	1 total hydrocarbon analyzer and recorder equipped to readout 0–100% HC as propane (FID or NDIR types are recommended).
	1 leak check system (Figure 4) (only 1 required).
5[1]	1 dry gas volume meter[2] and liquid trap (3 cfm).
	1 0–1" H_2O manometer-inclined.
1	1 dry gas volume meter (3 cfm).
	1 pressure-vacuum solenoid valve system (Figure 3).
	1 total hydrocarbon analyzer and recorder equipped to readout 0–100% HC as propane (FID or NDIR types are recommended).
2	1 flexible thermocouple with readout (0–100°F range).
	1 gasoline sample thief (ASTM 0–R70).

[1] Equipment indicated is required at each pump being tested.

6.3 Stage I operations at vacuum assisted systems.

6.3.1 Basic measurements required are described below. Referring to Figure 2, the sample points are numbered. The measurements indicated provide for the inclusion of the secondary control device efficiency. These are not required to determine compliance with an applicable subpart if it can be shown through volume measurements, that the secondary control device is not needed to comply with the respective subpart.

Sample point	*Measurements necessary*
1 (inlet to control device)	Hydrocrabon concentration.
2 (exhaust vent of control device).	Volume of exhaust vapors.
	Hydrocarbon concentrations.
3 (underground tank vent)	Check for hydrocarbon vapor leaks.
4 (underground tank)	Temperature of liquid (optional).
	Volume of liquid.
5 (tank of bulk delivery truck).	Temperature of liquid (optional).
	Pressure (optional).
	Check for hydrocarbon vapor leaks at all connections.

[1] Equipment indicated is required at each pump being tested.
[2] See paragraph 8.2.4.9.

6.3.2 The equipment required for the basic measurements are listed below. Alternative equipment may be used subject to the approval of the Administrator.

Sample point	*Equipment and specifications*
1	1 total hydrocarbon analyzer with recorder equipped to readout 0–100% HC as propane (FID or NDIR types are recommended).
2	1 volume dry gas meter (size depends on flow rate). 1 total hydrocarbon analyzer with recorder equipped to readout 0–100% HC as propane (FID or NDIR types are recommended).
3	Plastic bags (1–5 ft^3).
4	1 flexible thermocouple with readout (range 0–100°F).
5	1 flexible thermocouple with readout (range 0–100°F). 1 0–10" H_2O manometer. 1 combustible gas detector (0–100% LEL).

6.4 Stage II operations at vacuum assisted systems.

6.4.1 Basic measurements required are described below. Referring to Figure 2, the various sampling points in the system are numbered.

Sample point	*Measurements necessary*
6 (dispensing nozzle)	Temperature of vehicle tank gasoline prior to refueling (optional). Check for gasoline vapor leaks around nozzle-fillneck interface during refueling with combustible gas detector. Hydrocarbon concentration of returned vapors. Temperature of dispensed liquid (optional). Temperature of returned vapors (optional).
7 (vapor return line)	Volume of returned vapors. Pressure in vapor return line (optional).
8 (gas meter and pump)	Volume of gasoline dispensed during test period. Volume of gasoline dispensed for each vehicle used during tests.
1 (inlet to secondary control device).	Volume of gasoline vapors returned to control device. Hydrocarbon concentration of inlet vapors.
2 (exhaust vent of control device).	Volume of exhaust vapors. Hydrocarbon concentration of exhaust gases.
3 (underground tank vent)	Check for gasoline vapor leaks.
4 (underground tank)	Temperature of liquid in underground tank (optional). Volume of liquid. Sample for Reid vapor pressure analysis.

6.4.2 The equipment required for the basic measurements are listed below. Alternative equipment may be used subject to the approval of the Administrator.

Sample point	*Equipment and specifications*
6	3 flexible thermocouples (range 0–150°F). 1 portable combustible gas detector (at least 0–100% lower explosive limit). 1 total hydrocarbon analyzer with recorder equipped to read out 0–100% HC as propane (FID or NDIR types are recommended).
7	1 volume dry gas meter (size depends on flow rate).
1	1 volume dry gas meter (size depends on flow rate). 1 total hydrocarbon analyzer and recorder equipped to read out 0–100% HC as propane (FID or NDIR types are recommended).
2	1 volume dry gas meter (size depends on flow rate). 1 total hydrocarbon analyzer and recorder equipped to readout 0–20% HC as propane (FID or NDIR types are recommended).
3	Plastic bags (1–5 ft^3).
4	1 flexible thermocouple and readout (range 0–100°F). 1 gasoline sample thief (ASTM 0–270).

7. *Test Procedures*

7.1 Stage I operations at vapor balance systems.

7.1.1 Preparations for the testing include the following:

7.1.1.1 On the exhaust vent of the underground tank connect a dry gas meter.

7.1.2 Measurements and data required for evaluating the bulk tank truck drop include the following:

7.1.2.1 Record the temperature of the liquid in the bulk tank of the truck. (optional)

7.1.2.2 Attach a 0–10" H_2O manometer to the vapor return manifold on the truck so as to monitor and record the pressure inside the tank during the drop. (optional)

7.1.2.3 Record the temperatures (optional) and volumes of the liquid in the underground tanks that are to receive the gasoline delivery.

7.1.2.4 Record the time (optional) required for the drop and record the volume of liquid transferred.

7.1.2.5 During the transfer monitor all hose connections with the combustible gas detector and record any incidents of leaks. Record any incidents of spillage and estimate amounts.

7.1.2.6 Record any volume vented from the underground tank vent.

7.1.2.7 During the gasoline transfer, record the pressure inside the tank of the bulk delivery truck. (optional)

7.1.2.8 After the transfer hoses are disconnected, record volumes and temperatures (optional) of the underground tanks.

7.1.2.9 Record the volume of gasoline dispensed to vehicles during the bulk gasoline transfer.

7.1.2.10 Record the ambient temperature and pressure. Ambient temperature shall be measured with an aspirated thermometer shielded from radiation effects of sunlight.

7.2 Stage II operations at vapor balance systems.

7.2.1 Preparations for the testing include the following:

7.2.1.1 Connect into the vapor return line (sample point 5 on Figure 1) a dry gas volume meter. On the outlet of the meter, attach a tap for a sample hose. Connect the liquid trap upstream of the dry gas meter.

7.2.1.2 Connect to one tap a 0–1" inclined manometer. (optional)

7.2.1.3 Between the hoses and the dispensing nozzle (sample point 4 on Figure 1) place a connector that allows for the insertion of a thermocouple in the liquid dispensing line. This must be leak tight. A similar thermocouple connection in the vapor return line is optional. A second tap in the vapor return line connection for a sample hose is necessary for the THC analyzer.

7.2.1.4 Attach flexible thermocouples so that the dispensed gasoline temperature and the returned vapor temperature (optional) are detected. Connect these thermocouples to recorders so that records of the temperatures are kept during refueling.

7.2.1.5 Connect to the second tap in the vapor return hose nozzle connection a sample line for a total hydrocarbon analyzer. The sample pump for the THC analyzer should draw no more than 300 cubic centimeters per minute of sample. Arrangements should be made so that the sample line may be disconnected from the vapor return line when no refueling is in progress.

7.2.1.6 At the outlet of the underground vent (sample point 1 on Figure 1) connect a pressure sensitive solenoid valve system (Figure 3) that routes in-breathing and out-breathing through different ports. Arrange pressure switches so that one opens one solenoid valve at a negative pressure and the other pressure switch opens another valve at a positive pressure. These pressures should be less than |0.2| inches of water.

7.2.1.7 On the out-breathing port of this valve connect a dry gas meter with a tap on the outlet side for a total hydrocarbon analyzer sample. Connect the THC analyzer.

7.2.1.8 Calibrate and span all instruments according to the steps outlined in section 9.

7.2.1.9 On each day of the testing record initial and final volume readings from all pumps at the service station. Record initial and final underground tank temperatures (optional) and volumes. (Sample points 6 and 2 on Figure 1.)

7.2.1.10 At the beginning of the testing period determine the liquid flow rate of the nozzles to be used in the testing in each of the latched positions. This shall be done by pumping at least 10 gallons of gasoline in each latched position and recording the amount of gasoline pumped and the elapsed times for the pumping.

7.2.1.11 At the beginning of the testing period and every hour during the testing period, record the ambient temperature and pressure. Ambient temperature shall be measured with an aspirated thermometer shielded from the radiation effects of sunlight.

7.2.1.12 At the beginning of the test period, obtain a gasoline sample from the underground tank under test according to procedure outlined in ASTM 0–270, part 27. Have the sample analyzed to determine Reid Vapor Pressure according to ASTM 0–323.

7.2.2 Measurements and data required for each automobile used for the vehicle refueling test include the following:

7.2.2.1 Record license number, State of registration, make, model (optional), and year of each car tested.

7.2.2.2 Measure and record the temperature of the gasoline in the tank of the vehicle.

7.2.2.3 Time the refueling operation so as to obtain the total time interval for dispensing gasoline (optional) and the total time interval that the nozzle is attached to the vehicle fillneck (optional).

7.2.2.4 During refueling check around the vehicle fillneck-nozzle interface with the combustible gas detector, the sample inlet held approximately 1 cm from the interface. Explore with the sample probe the entire periphery during the complete refueling operation and for at least ten seconds after shutoff. Record any incidents of detectable leaks of hydrocarbon vapors. This step is required only for those vehicles which are required for possible use in determining potential emissions under 7.2.3.

7.2.2.5 After the refueling operation begins record the pressure in the vapor return line (optional).

7.2.2.6 At the end of the refueling, record the volume of gasoline dispensed and the final volume reading on the dry gas meter in the vapor return line.

7.2.2.7 Record any incidents of spitback or spillage and estimate amounts.

7.2.3 For vehicles that are to be used for determination of potential emissions, the following steps are required in addition to those listed previously.

7.2.3.1 Prior to refueling determine whether the automobile has an evaporative emission control carbon cannister (most post 1970 vehicles) or an atmospheric vent (pre-1970 vehicles). For those vehicles with atmospheric vents attach the manometer to the vent outlet effectively blocking the outlet. During refueling monitor this pressure in the vehicle tank.

7.2.3.2 As necessary equip the dispensing nozzle with a flexible seal that prevents vapor leaks at the fillneck-nozzle interface. During refueling force a good seal at this interface and check for leaks with the combustible gas detector.

7.2.3.3 Fill the vehicle tank to within 2–3 gallons of complete filling. After stopping of dispensing, maintain a tight seal at the fillneck-nozzle interface until the vehicle tank pressure reaches 0" H_2O or less and the vapor line pressure reaches 0" H_2O or less.

7.2.3.4 After refueling, leak check the vehicle tank with the equipment shown in Figure 4 at a pressure of 3" H_2O. Record any incidents of leaks.

7.2.4 The leak test procedure is as follows:

7.2.4.1 Test equipment.

a. Nitrogen cylinder.

b. Manual gas flow valve.

c. Liquid holding tank.

d. Glass tube straight, ¼" I.D. x 12" long.

e. Flexible plastic tubing, 10" long x ¼" diameter.

f. 10 cfh rotameter (less than ½" H_2O pressure drop recommended).

g. Size 11½ rubber stopper.

h. Plastic "T", ¼' I.D.

i. Mounting board with change for glass tube.

7.2.4.2 Connect nitrogen cylinder, flow valve, straight glass tube, flexible tubing, flow meter, and rubber stopper as shown in Figure 4.

7.2.4.3 Mount the equipment on the mounting board.

7.2.2.4.4 Fill the liquid holding tank to at least 6" depth with water.

7.2.4.5 For those automobiles with evaporative emission control canisters, find the hose leading from the fuel tank to the cannister. Clamp this line tightly to prevent any leakage. For those vehicles with atmospheric vents, block the vent opening to prevent any leakage during the leak test. Some atmospheric vents lead to the tank fillneck (cap vented tanks) and need not be blocked.

7.2.4.6 Place open end of glass tube beneath the surface of the water in the holding tank and measure ΔH. Set at 3" H_2O.

7.2.4.7 Place rubber stopper of vehicle tank fillneck and hold firmly to prevent leaks.

7.2.4.8 Allow nitrogen to flow by opening the valve until bubbles flow at the open end of the tube submerged in the holding tank.

7.2.4.9 Adjust the flow until the bubble just appears at the bottom of the glass tube and record the flow rate from the flow meter. This flow rate is the leak rate.

7.2.4.10 Repeat steps 7.1.4.7 and 7.1.4.8 for varying ΔH's. Vary from ½" to 3" H_2O. (optional)

7.3 Stage I operations at vacuum assisted systems.

7.3.1 Preparations for the testing include the following:

7.3.1.1 Connect to the exhaust vent of the control device (sample point 2 of Figure 2) a dry gas volume meter. Attach a tap for a sample hose to the outlet of the volume meter.

7.3.1.2 Connect to the tap a THC analyzer capable of measuring 0–20% HC as propane.

7.3.1.3 Over any underground vent with or without a pressure-vacuum valve, attach a plastic bag effectively capturing any leakage from the vent. (Sample point 3 of Figure 2)

7.3.2 Measurements and data required for evaluating the bulk tank truck delivery include the following:

7.3.2.1 Record the temperature of the liquid in the bulk tank of the truck. (optional)

7.3.2.2 Attach a 0–10" H_2O manometer to the vapor return manifold on the truck so as to monitor the pressure inside the tank during the delivery. (optional) (sample point 5 on Figure 2)

7.3.2.3 Record the temperatures and volumes of the liquid in the underground tanks that are to receive the gasoline delivery.

7.3.2.4 Record the time (optional) required for the drop and record the volume of liquid transferred.

7.3.2.5 During the transfer monitor all hose connections with the combustible gas detector and record any incidents of leaks. Record any incidents of spillage and estimate amounts.

7.3.2.6 Record the volume entering the secondary control device and the corresponding temperature.

7.3.2.7 Record any volume vented from the vent of the control device and record the corresponding concentration.

7.3.2.8 During the gasoline transfer, record the pressure inside the tank of the bulk delivery truck. (optional)

7.3.2.9 After the transfer hoses are disconnected record volumes and temperatures (optional) of the underground tanks.

7.3.2.10 Record the volume of gasoline dispensed to vehicles during the bulk gasoline transfer.

7.3.2.11 Record any incidents of leakage from the vent outlet from the underground tank by noting filling of the bag over the vent. Estimate the volume and elapsed time for the leakage.

7.3.2.12 Record ambient temperature and pressure. Ambient temperature shall be measured with an aspirated thermometer shielded from the radiation effects of sunlight.

7.4 Stage II operations at vacuum assisted systems.

7.4.1 Preparations for the testing include the following:

7.4.1.1 Connect into the vapor return line (sample point 7 on Figure 2) a dry gas volume meter. On the outlet of the meter, attach one tap for a sample hose. Connect the liquid trap upstream of the dry gas meter.

7.4.1.2 Connect to tap a 0–10" inclined manometer. (optional)

7.4.1.3 Between the hoses and the dispensing nozzle (sample point 6 on Figure 2) place a connector that allows for the insertion of a thermocouple in the liquid dispensing line. This must be leak tight. A similar thermocouple in the vapor return line is optional. A second tap in the vapor return line is necessary for the THC analyzer.

7.4.1.4 Attach flexible thermocouples so that the dispensed gasoline temperature and the returned vapor temperature (optional) are detected. Connect these thermocouples to recorders so that records of the temperatures are kept during refueling.

7.4.1.5 Connect to the second tap in the vapor return line nozzle connection a sample line for a total hydrocarbon analyzer capable of measuring 0–100% HC as propane. The sample pump for the THC analyzer should draw no more than 300 cubic centimeters per minute of sample. Arrangements should be made so that the sample line may be disconnected from the vapor return line when no refueling is in progress.

7.4.1.6 Connect to the inlet to the secondary control system (sample point 1 on Figure 2) a dry gas flow meter. Determine approximately what the flow rate will be in this line and choose an appropriately sized meter. Attach a tap for sample hose on the outlet of the volume meter.

7.4.1.7 Connect to the tap a THC analyzer capable of measuring 0–100% HC as propane. The analyzer should be equipped with a recorder.

7.4.1.8 Connect to the exhaust vent of the secondary control device (sample point 2 of Figure 2) an appropriately sized dry gas flow meter. Attach a tap for a sample hose to the outlet of the volume meter.

7.4.1.9 Connect to the tap a THC analyzer with recorder capable of measuring 0–20% HC as propane.

7.4.1.10 Over any underground vent with or without a pressure vacuum valve, attach a plastic bag effectively capturing any leaks from the vent. (Sample point 3 of Figure 2)

7.4.1.11 Calibrate and span all instruments as outlined in Section 9.

7.4.1.12 At the beginning of the test period, obtain a gasoline sample from the underground tank under test according to ASTM 0–270, part 27. Analyze the sample to determine the Reid Vapor Pressure according to ASTM 0–323.

7.4.2 Measurements and data required for determining system emission rates during vehicle refueling include the following:

7.4.2.1 Record the temperature (optional) of the liquid in each underground tank as well as volume. (Sample point 4 on Figure 2.)

7.4.2.2 Each day of the test record the initial liquid volume readings on each pump at the service station at the beginning of the test. Each day, record the final liquid volume pump readings at the completion of the test day.

7.4.2.3 Record the initial volume readings from the dry gas volume meters at the inlet and outlet of the secondary control device at the beginning of the test.

7.4.2.4 At the beginning of the testing period and each hour during the testing period, record the ambient temperature and pressure. Ambient temperature shall be measured with an aspirated thermometer shielded from the radiation effects of sunlight.

7.4.2.5 Record license number, State of registration, make, model (optional), and year of each car tested.

7.4.2.6 Measure and record the temperature of the gasoline in the tank of the vehicle.

7.4.2.7 Prior to refueling record the initial dry gas meter reading.

7.4.2.8 Time the refueling operation so as to obtain the total time interval for dispensing gasoline (optional) and the total time interval that the nozzle is attached to the vehicle fillneck (optional).

7.4.2.9 After the refueling operation begins record the pressure in the vapor return line (optional).

7.4.2.10 During refueling, check around the vehicle fillneck-nozzle interface with the combustible gas detector with the sample inlet held approximaely 1 cm from the interface. Explore with the sample probe the entire periphery during the complete refueling operation and at least ten seconds after shutoff. Record any incidents of detectable leaks of hydrocarbon vapors and the magnitude in terms of percent of lower explosive limit. Record the highest explosimeter reading (expressed as % LEL) which occurs for a duration of 10 seconds or more.

7.4.2.11 At the end of the refueling, record the volume of gasoline dispensed and the final volume reading on the dry gas meter. Record the average hydrocarbon concentration from the total hydrocarbon analyzer.

7.4.2.12 Record any incidents of spillback or spillage (as defined in any applicable subpart) and estimate amounts.

7.4.2.13 Monitor and record the HC concentration of vapors at the inlet and the outlet of the secondary control device. Keep a record of volume readings associated with any changes in HC concentration.

7.4.2.14 Record any incidents of leakage from the vent outlet from the underground tank by noting any filling of the bag over the vent. Estimate the volume and elapsed time for the leakage.

8. *Calculations*

8.1 Stage I operations at vapor balance systems.

8.1.1 Terminology.

V_e = Volume of hydrocarbon vapors exhausted from the underground tank vent line (ft^3).
V_f = Final volume reading on dry gas meter (ft^3).
V_i = Initial volume reading on dry gas meter (ft^3).
M_e = Mass of exhausted hydrocarbon vapors (g).
C_e = Concentration of exhausted hydrocarbons (%/100 as propane).
P_a = Ambient pressure (inches Hg.).
T_a = Ambient temperature (°F).
T_u = Underground tank temperature (°F).
E_{vol} = Volume efficiency of collection (%).
E_{mass} = Mass efficiency of collection (%).
V_l = Volume of liquid transferred (gal).
V_b = Estimated leakage volume not measured at vent (ft^3).

8.1.2 Determine for the bulk loading evaluation:

8.1.2.1 The volume of hydrocarbon vapors exhausted from the underground tank vent line.

$$V_e = V_f - V_i + V_b$$

8.1.2.2 Volume of liquid dropped from the tank truck to the bulk tank during the test period—V_l. Compare the underground tank readings before and after the drop with the volume reported dropped. If an inconsistency occurs, take steps to correct the volume value.

8.1.2.3 Calculate the volume efficiency.

$$E_{vol} = 100 - 748.1 \frac{V_e(T_u + 460)}{V_l(T_a + 460)}$$

8.1.2.4 Assume that the concentration of hydrocarbon vapors emitted from the exhaust vent is the same as for the vapors returned to the tank truck so that the mass efficiency is:

$$E_{mass} = E_{vol}$$

8.2 Stage II operations at vapor balance systems.

8.2.1 Terminology.

V_r = Net returned vapor volume (ft^3).
V_f = Final volume meter reading in vapor return hose (ft^3).
V_i = Initial volume meter reading (ft^3).
V_l = Dispensed liquid volume (gal).
V/L = Vapor volume to liquid volume ratio.
t = Fill time (min).
R_d = Gasoline dispensing rate (gal/min).
T_v = Vehicle tank temperature (°F).
T_u = Underground tank temperature (°F).
T_d = Dispensed liquid temperature (°F).
T_r = Returned vapor temperature (°F).
M_r = Mass of returned hydrocarbons (g).
C_r = Hydrocarbon concentration in vapor return line (% as propane).
M/L = Mass of hydrocarbon returned to dispensed liquid volume ratio (g/gal).
C_e = Hydrocarbon concentration in vented exhaust gas (%/100 as propane).
V_e = Volume of vented exhausted gas (ft^3).
M_e = Mass of hydrocarbon exhausted from the underground tank vent (g).
P_a = Ambient pressure (inches Hg).
T_a = Ambient temperature (°F).
$(M/L)_e$ = Mass emission rate (g/gal).

8.2.2 Determine for all automobiles used for the testing.

8.2.2.1 Volume of returned vapors.

$$V_r = V_f - V_i$$

8.2.2.2 Volume to liquid ratio.

$$V/L = 7.481 \frac{V_r}{V_l}$$

8.2.2.3. Dispensing rate.

$$R_d = \frac{V_l}{t}$$

8.2.2.4 Vehicle tank—underground tank temperature difference.

$$\Delta T_{vu} = T_v - T_u$$

8.2.2.5 Vehicle tank—dispensed liquid temperature difference.

$$\Delta T_{vd} = T_v - T_d$$

8.2.2.6 Standard returned vapor volume.

$$V_{rs} = \frac{17.71\ V_r P_a}{T_a + 460}$$

8.2.2.7 Mass of hydrocarbon vapor returned.

$$M_r = 51.7\ V_{rs} C_r$$

8.2.2.8 Mass returned to volume dispensed ratio.

$$M/L = \frac{M_r}{V_l}$$

8.2.3 For the potential emissions baseline curve complete the following steps.

8.2.3.1 From the total list of automobiles, separate all automobiles that had the vent lines from the vehicle tank blocked and/or were force-fit at the nozzle-fillneck interface. Of these vehicles, identify those which had no hydrocarbon leaks at the nozzle-fillneck interface and no leaks in the vehicle tank when leak tested. These automobiles and the measured data for them will be used for the potential emissions baseline curve. All other force-fit automobiles or vehicles fueled while vent lines were physically blocked will be omitted from any further data analyses.

8.2.3.2 Calculate and plot for the baseline vehicles a least-squares straight line curve using V/L as the dependent variable and ΔT_{vu} as the independent variable. (optional)

8.2.3.3 Calculate and plot for the baseline vehicles a least-squares straight line curve using M/L as the dependent variable and ΔT_{vd} as the independent variable. Alternately, a nonlinear parametric curve may be derived if such a curve provides equal or better correlation as compared to the linear curve. In accordance with paragraph 4.2 which provides for the potential use of theoretically derived baseline curves, theoretically derived curves may, subject to approval, be produce dand verified with the M/L, ΔT_{vd} and other data collected from the baseline vehicles. If this is done, complete supporting data and identification of all parameters used in the derived curves shall be supplied.

8.2.4 To determine the mass emission rate for automobiles filled in the normal manner, complete the following steps.

8.2.4.1 Eliminate from the data set all vehicles that were force-fit at the nozzle-fillneck interface or were hand held during refueling, including those that were not used for the baseline determination. Every effort must be made during the vehicle refueling testing program to insert dispensing nozzles into the vehicle fillnecks so that the nozzles may be latched in place to allow for dispensing in a hands-off manner. Where this is not practical or normal practice, hand held dispensing is allowed, but data from such tests shall be deleted from any analysis.

8.2.4.2 Using the least-squares curve calculated in section 8.2.3.3, determine for each car a value for M/L at the respective ΔT values. This will be called the potential mass returned to liquid ratio $(M/L)_{pot}$.

8.2.4.3 Determine for each automobile the mass of potential returned vapors, M_{pot}.

$$M_{pot} = V_l (M/L)_{pot}$$

8.2.4.4 Sum the masses of potential returned vapors, ΣM_{pot}.

8.2.4.5 Sum the masses of returned vapors, ΣM_r, found in Section 8.2.2.7 for all tested vehicles excluding the force-fit automobiles and/or those with blocked vent lines.

8.2.4.6 Determine the total volume of gasoline dispensed at the service station during the testing period. If the vapor recovery system is such that different gasoline products have separate vent lines, determine the dispensed volume only for the product or products used for the test. This value is V_s. Compare the daily underground tank volume readings with the daily pump volume readings. If an inconsistency occurs, determine the correct value.

8.2.4.7 Calculate the mass of hydrocarbons lost through the vent line during the test period. Include any breathing losses while the station is closed if such losses occurred during the test period. This value is M_e.

8.2.4.8 Determine hydrocarbon emission rate:

$$(M/L)_e = \frac{\Sigma M_{pot} - \Sigma M_r}{\Sigma V_l} + \frac{M_e}{V_s}$$

8.2.4.9 The physical presence of certain sampling system components in the vapor return line and/or vent pipe may have an adverse effect on the performance of some vapor balance systems. This effect is the re-

sult of a pressure differential created by the dry gas volume meters and the other sampling instrumentation in the line and on the vent outlet. During in-breathing conditions, the meter pressure may be partially offset by negative pressure maintained in the system by the vacuum switches on the exhaust vent. Under conditions of tank equilibrium or tank out-breathing, the effect of the meter and the pressure vacuum switches may be additive. The calculations and procedures presented here do not take into account or provide a correction for any effect caused by the monitoring equipment. It is intended, however, that any effect resulting from the presence of the monitoring equipment be compensated for in determining the hydrocarbon mass emission rate. Therefore, appropriate use of such techniques as zero pressure drop metering mechanisms, or calculated correction factors along with supporting data should be included in the mass emission test and/or calculation procedure.

8.2.4.10 Determine the total number of vehicle fillings during which spitback or spillage was recorded. Report this number on the basis of number of spitback or spillage occurrences per 100 fillings.

8.3 Stage I operations at vacuum assisted systems.

8.3.1 Terminology.

E_{mass} = Mass efficiency.
V_e = Volume of exhaust gas (ft^3).
V_f = Final dry gas meter volume reading (ft^3).
V_i = Initial dry gas meter volume reading (ft^3).
V_{es} = Standard volume of exhaust gases (SCF).
P_a = Ambient pressure (inches Hg).
T_a = Ambient temperature (°F).
P_s = Atmospheric pressure (inches Hg).
C_e = Concentration of exhaust gases (%/100 as propane).
C_r = Concentration of vapors entering control device (%/100 as propane).
V_l = Total transferred gasoline volume (gal).
V_k = Estimated volume of leakages (SCF).

8.3.2 Determine the following for the bulk loading evaluation.

8.3.2.1 Volume of exhausted hydrocarbon vapors from the secondary process equipment.

$$V_e = V_f - V_i$$

8.3.2.2 Standard volume of exhaust gas.

$$V_{es} = \frac{17.71 V_e P_a}{T_a + 460}$$

8.3.2.3 Mass of exhausted hydrocarbons.

$$M_e = 51.7(V_s C_e + V_k C_r)$$

8.3.2.4 Determine the total volume of gasoline delivered during bulk loading. Compare the underground tank readings of volume with the recorded volume. If an inconsistency occurs, determine the correct volume—V_l.

8.3.2.5 Calculate the mass emission rate (optional).

$$(M/L)_e = \frac{M_e}{V_l}$$

8.3.2.6 Calculate mass efficiency.

$$E_{mass} = 100 - 14.14 \frac{M_e}{V_l C_r}$$

8.4 Stage II operation at vacuum assisted systems.

8.4.1 Terminology

V_r = Volume of returned vapors for vehicle refueling (ft^3).
V_{ri} = Initial dry gas meter reading in vapor return line (ft^3).
V_{rf} = Final dry gas meter reading in vapor return line (ft^3).
V_{rs} = Standard returned vapor volume (SCF).
P_a = Ambient pressure (inches Hg).
T_a = Ambient temperature (°F).
M_r = Mass of returned vapors for each vehicle (g).
V_l = Volume of liquid dispensed for each tested automobile (gal).
C_r = Concentration of returned vapors (%/100 as propane).
M/L = Mass of hydrocarbon vapor per volume of liquid (g/gal).
V_p = Volume of vapors flowing to processing equipment (ft^3).
M_p = Mass of hydrocarbon vapor entering control device (g).
R = Explosimeter reading (% LEL).
V_v = Estimated volume of hydrocarbon vapors lost from vehicle fillneck during refueling (gal).
C_p = Concentration of vapors at inlet to processing equipment (%/100 as propane).
L_l = Total volume of liquid dispensed during test period.
V_e = Volume of gas exhausted from control system (ft^3).
C_e = Concentration of gases at exhaust of processing equipment (%/100 as propane).
M_c = Mass of hydrocarbon vapor exhausted from control device (g).
V/L = Volume of vapor per volume of liquid dispensed (ft^3/gal).
V_{cs} = Volume of calculated excess vapors to be processed by the control equipment during the test period (ft^3).
E_p = Efficiency of control equipment (%).

8.4.2 Determine the following variables for vehicle refueling evaluation.

8.4.2.1 Volume of vapors returned for each vehicle used during the test period.

$$V_r = V_{rf} - V_{ri}$$

8.4.2.2 Standard volume of returned gases for each automobile.

$$V_{rs} = \frac{17.71 V_r P_a}{T_a + 460}$$

8.4.2.3 Mass of returned vapor for each automobile.

$$M_r = 51.7 V_{rs} C_r$$

8.4.2.4 For those vehicle fillings that had explosimeter readings of 10 seconds duration or longer in excess of 0.1 LEL, the following table, Table 8-1, is to be used to estimate the leakage volume, V_v for each vehicle.

TABLE 8-1

Maximum explosimeter reading, R	*Leakage volume, V_v (gal)*
R≤0.1 LEL	0.
0.1 LEL≤R≤0.5 LEL	0.10 V_l.
0.5 LEL≤R≤1.0 LEL	0.35 V_l.
1.0 LEL<R	0.50 V_l.

8.4.2.5 Calculate the estimated hydrocarbon mass leakages for each vehicle.

$$M_v = 6.91 V_{vs} C_r$$

8.4.2.6 Sum the estimated hydrocarbon mass leakages, ΣM_v.

8.4.2.7 Mass per volume of liquid for each automobile.

$$(M/L)_r = \frac{M_r}{V_l}$$

8.4.2.8 Average $(M/L)_r$.

$$(M/L)_r = \frac{\Sigma M_r}{\Sigma V_l}$$

8.4.2.9 Volume of vapors flowing to inlet of control device.

$$V_p = V_{pf} - V_{pi}$$

8.4.2.10 Standard volume of vapors flowing to processing equipment.

$$V_{ps} = \frac{17.71 V_p P_a}{T_a + 460}$$

Note: If the dry gas meter at the inlet to processing equipment is at a substantially different temperature and/or pressure from ambient conditions, substitute the proper values for P_a and T_a.

8.4.2.11 Mass of vapors at inlet of processing equipment.

$$M_p = 51.7 V_{ps} C_p$$

8.4.2.12 Mass per volume of liquid at inlet of processing equipment.

$$(M/L)_p = \frac{M_p}{L_l}$$

8.4.2.13 Volume of exhausted gases from control system.

$$V_e = V_{ef} - V_{ei}$$

8.4.2.14 Standard volume of exhausted gases.

$$V_{es} = \frac{17.71 V_e P_a}{T_a + 460}$$

Note: If temperature and/or pressure of the gas meter at the exhaust of the processing equipment is substantially different from ambient conditions, substitute the proper values for P_a and T_a.

8.4.2.15 Mass of exhausted vapors plus estimated leaked vapors.

$$M_e = 51.7 V_{es} C_e + \Sigma M_v$$

8.4.2.16 Mass per volume of liquid dispensed:

$$(M/L)_e = \frac{M_e}{L_l}$$

8.4.2.17 Volume of vapors returned per volume of liquid dispensed average:

$$\overline{(V/L)}_r = \frac{\Sigma V_r}{\Sigma L_r}$$

8.4.2.18 Total volume of vapors returned from all pumps during test period:

$$V_t = L_l (V/L)_r$$

8.4.2.19 If the vapor recovery system uses the underground tanks as holding tanks for some of the collected vapor, calculate the volume excess to be processed:

$$V_{ps} = V_t - 0.1337 L_l$$

If all the vapors collected during refueling operations are processed by the control system—

$$V_{ps} = V_t$$

8.4.2.20 Compare V_p and V_{ps}.

If $V_{ps} > V_p$, substantial leaks may exist in the control system or in the underground piping. If V_{ps} exceeds 1.2 V_p, the test results shall be considered invalid.

8.4.2.21 Efficiency of processing equipment (optional).

$$E_p = 100 \frac{(M/L)_e}{(M/L)_r}$$

8.4.2.22 Determine the total number of vehicle fillings during which spitback or spillage was recorded. Report this number on the

basis of number of spitback or spillage occurrences per 100 fillings.

8.4.2.23 Mass emission rate.

$$(M/L)_e = \frac{M_e}{V_e}$$

9. *Calibrations.*

9.1 Flow meters. Standard methods and equipment subject to approval by the Administrator shall be used to calibrate the dry gas meter.

9.2 Temperature recording instruments. Calibrate daily prior to test period and immediately following test period using ice water (32°F) and a known temperature source about 100°F.

9.3 Total hydrocarbon analyzer. Follow the manufacturer's instructions concerning warm-up time and adjustments. On each test day, at least once prior to, and once after each test period, zero the instrument with zero gas (<3 ppm C) and span with a known concentration of propane at about 70% concentration for the displacement systems tests and about 20% concentration for the vacuum assist systems tests. (Note: If butane is substituted for propane as the calibration gas span at about 50% conceneration and make suitable corrections in the calculation.) Prior to and following the testing period, perform a comprehensive calibration in the laboratory. Check the instrument with varying known concentrations of propane and butane to determine linearity.

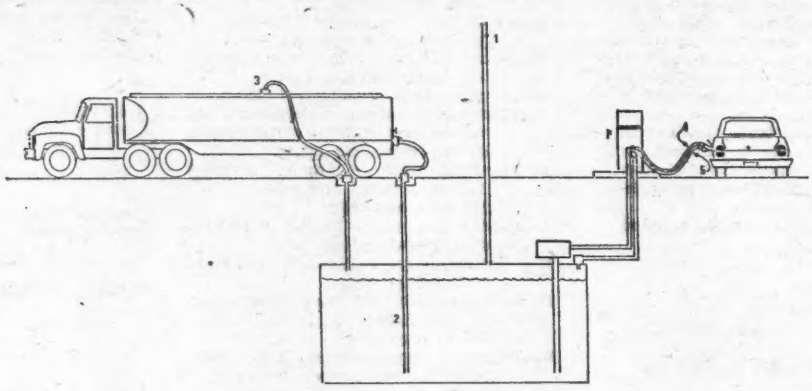


Figure 1. Vapor balance system.

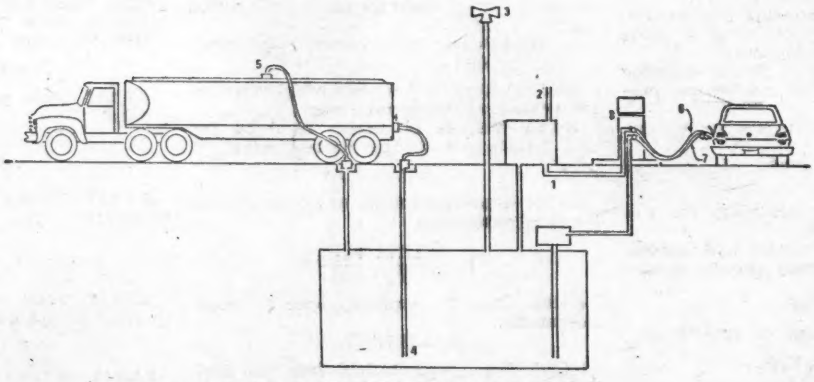


Figure 2. Vacuum assisted secondary system.

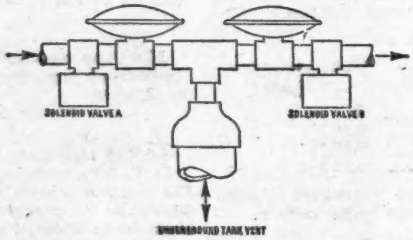


Figure 3. Differential pressure switches (<0.2 in. H_2O).

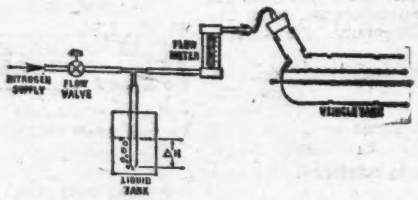


Figure 4. Leak test system.

V. Tentative Alternate Field Test Procedures for Determining Emissions at the Vehicle During Vehicle Refueling With Vapor Balance Systems

Introduction

This method is set forth in a limited form applicable only to determination of hydrocarbon vapor losses occurring during vehicle refueling operations using vapor balance control equipment. The method, if approved, will replace or may be used as an alternative to the respective paragraphs of the method set forth in Section IV of this appendix.

1. *Principle.*

Pressure in the vehicle fillneck is monitored during refueling and compared with a previously determined relationship between hydrocarbon leak rate and fillneck pressure. Results are expressed as grams of hydrocarbons emitted per gallon of gasoline dispensed.

2. *Applicability.*

This method is applicable to determining emission rates from a vehicle fuel tank at a vapor balance recovery system during vehicle refueling.

3. *Summary of Method.*

3.1 This test method can be performed during normal operation of the service station on customer vehicles or on test tanks. It involves determination of the relationship between leak rate from the vehicle tank and fillneck pressure with the vapor recovery dispensing nozzle latched in place on the tanks before refueling. Hydrocarbon vapors from an underground tank are used to pressurize the vehicle tank. The pressure in the fillneck is monitored while the volume leak rate is measured with a dry gas meter for several different fillneck pressures.

During refueling, hydrocarbon concentration in the vapor return line is monitored. The pressure in the fillneck is recorded throughout the filling operation. The volume of leakage during the refueling is determined from the leak rate versus pressure curve. The mass emission rate can be calculated using the leakage volume and the hydrocarbon concentration.

4. *Basic Measurements and Equipment Required.*

4.1 Basic measurements required for evaluation of the displacement vapor recovery vehicle refueling system are below. Referring to Figure 1, the various sampling points in the system are numbered.

Sample point	*Measurements necessary*
1. (Dispensing nozzle and vehicle fillneck).	Static pressure in fillneck during leak rate measurement. Static pressure in fillneck during vehicle refueling. Hydrocarbon concentration of returned gasoline vapors. Temperature of returned gasoline vapors.
2. (Vapor return hose)	Volume of vapor leaked during leak rate determination.
3. (Gasoline meter and pump)	Volume of gasoline dispensed for each vehicle. Volume of gasoline dispensed during test period.

4.2 The equipment required for the basic measurements are below.

Sample point	*Equipment and specifications*
1*	1 pressure transducer and recorder. 1 modified dispensing nozzle equipped for pressure tap. 1 total hydrocarbon analyzer and recorder equipped to readout 0–100% HC as propane. 1 flexibel thermocouple and recorder (range 0–150°F).
2*	1 by-pass system on vapor return hose (see Figure 2). 1 pump (3 CFM). 1 dry gas volume meter (3 CFM). 2 control valves.

* Equipment indicated is required at each pump being tested.

5. *Test Procedures*

5.1 Determination of leak rate at various fillneck pressures.

5.1.1 Preparation for testing include the following:

5.1.1.1 At a break in the vapor return line place a vapor close-off valve with a restriction no smaller than the vapor hose inside diameter.

5.1.1.2 Attach two taps immediately behind the dispensing nozzle in the vapor return line.

5.1.1.3 Connect one tap to the hydrocarbon analyzer and recorder with a strip chart. The sample pump for the THC analyzer should draw no more than 300 cubic centimeters per minute of sample. Arrangements should be made so that the sample line may be disconnected from the vapor return line when no refueling is in process.

5.1.1.4 Connect to the other tap the flexible thermocouple and recorder.

5.1.1.5 Modify the dispensing nozzle so that the static pressure near the tip of the nozzle in the fillneck may be monitored. This modification should create little or no interference with the flow through the nozzle.

5.1.1.6 Connect to this nozzle pressure tap the pressure transducer and recorder. The range of fillneck pressures is from 0 to 2" H_2O.

5.1.1.7 In a vapor return line that is connected to a different product than the product used for test, connect a pressurizing system as shown in Figure 2. This requires a pump, dry gas meter, and a control valve.

5.1.2 The following steps must be conducted for every automobile used for the test. Prior to refueling determine the leak rate at a minimum of three fillneck pressures (suggested pressures 0.1", 0.3", and 0.5" H_2O).

5.1.2.1 Record for every automobile the license number, State of registration, make, and year. Record also date and time of test.

5.1.2.2 Close the vapor close-off valve in the vapor return line under test so that the vapor return line is closed to gas flow.

5.1.2.3 Attach the dispensing nozzle to the vehicle fillneck so that a hands-off situation exists. Turn on the pressure transducer to monitor the fillneck pressure. Do not begin dispensing gasoline.

5.1.2.4 Turn on the vapor pump in the second vapor return line and adjust the control valve in the line until the pressure in the fillneck is at the desired level and monitor the instant level. Time the metered volume over a convenient volume (suggest a minimum of 0.1 cubic feet or 30 seconds). Record the volume and time with the fillneck pressure. Repeat for other fillneck pressures. Should no leak exist, so note.

5.1.2.5 Record atmospheric conditions including barometric pressure and atmospheric temperature.

5.1.3 The leak measurement during refueling is described in the following steps.

5.1.3.1 Leave dispensing nozzle in place. Connect and turn on the hydrocarbon analyzer with recorder, the temperature sensor and recorder and the pressure recorder. Turn off the vapor pump in the by-pass line and close the control valve.

5.1.3.2 Open the by-pass valve in the vapor return line to full open. Start fuel dispensing without moving the nozzle. Time the duration of flow and mark in the three strip charts the initiation of dispensing along with the license number of the automobile used in the test.

5.1.3.3 When dispensing is complete (do not top off) record the total volume of gasoline dispensed and the time for dispensing.

5.1.3.4 Replace dispensing nozzle in pump and disconnect hydrocarbon sampling line. Turn off recorders and return strip charts from test.

6. *Calculations.*

6.1 Calculations for the displacement vapor recovery system vehicle refueling evaluation are below in summary form. These steps must be completed for each vehicle.

6.1.1 Calculate the leak rates from the volume and time measurements in part 5.1.2.4. Plot these against the corresponding fillneck pressures on log-log paper.

6.1.2 Select a convenient time interval between 10 and 15 seconds for reading the fillneck pressure strip chart obtained during the dispensing period. Record the fillneck pressure at the middle of each time interval.

6.1.3 Convert each pressure value to a leak rate using plot established in step 8.1.1.

6.1.4 Determine the sum of the leak rate values and multiply by the averaging time interval to obtain a total volume leaked during dispensing.

6.1.5 Using the same time interval as for the pressure recording, record the hydrocarbon concentrations from the strip chart. Compensate for the sample lag time in obtaining the proper concentration level.

6.1.6 Convert each hydrocarbon concentration reading to concentration in grams per standard cubic foot with the calibration data for the instrument. Correct to standard temperature and pressure.

6.1.7 Calculate the grams of hydrocarbon lost during each interval: (time interval) (leak rate) (concentration)=grams

6.1.8 Calculate the mass loss rate.

$$\left(\frac{\text{total grams}}{\text{gallons dispensed}}\right)=\text{grams/gallon}$$

FIGURE 1
DISPLACEMENT SYSTEM

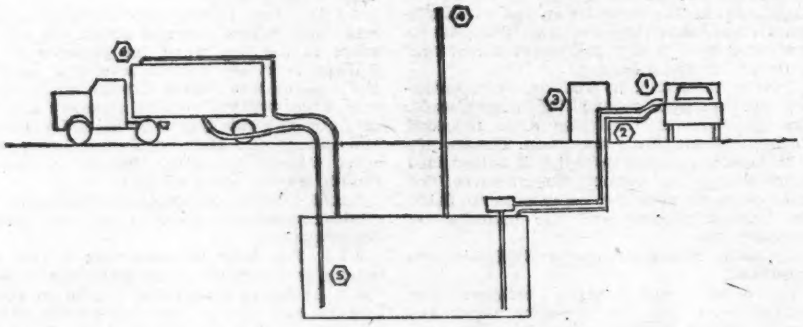
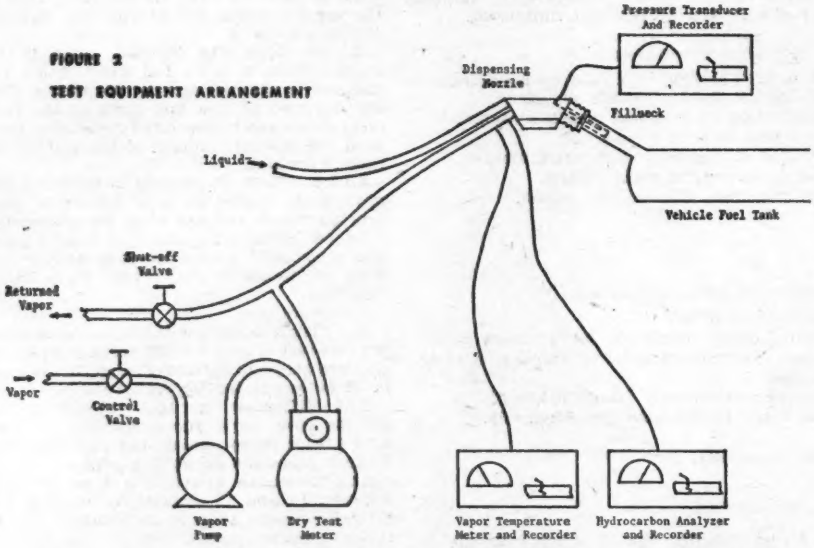


FIGURE 2
TEST EQUIPMENT ARRANGEMENT



VI. Tentative Alternative for Measuring Volume of Hydrocarbon Vapors During Vehicle Refueling Operations With Vapor Balance Control Systems

INTRODUCTION

This device is described in limited form applicable only to determination of returned vapor volume during vehicle refueling operations at vapor balance control systems. The volume measuring technique, if approved, would replace or be used as an alternative to the respective paragraphs of the method set forth in Section IV of this appendix.

1. *Principle.*

Hydrocarbon vapors displaced from the vehicle tank during refueling are routed to a flexible, inert or properly conditioned plastic bag where they are stored until the refueling operation is complete. A pump then evacuates the bag and the volume is measured with a dry gas meter. The vapors are pumped to the underground tank.

2. *Applicability.*

This volume measuring device is applicable to determining the volume of hydrocarbon vapors returning to the underground storage tank via the vapor return hose during the vehicle refueling operation at vapor balance recovery systems.

3. *Summary of Method.*

The volume measuring system is shown in Figure 1. Vapor returning via the vapor return line passes into a collapsed plastic bag that inflates inside a protective sealed drum. The volume displaced from the drum goes to the underground storage tank. At the conclusion of the refueling operation, appropriate valves are closed. Then the vapor in the bag is drawn through a dry gas meter until the bag is collapsed. This vapor is returned to the drum and remains there until displaced during the next refueling. The volume measurement is used to calculate mass of hydrocarbon vapors returned with other data gathered in Section IV of this appendix.

4. *Operating Procedure.*

4.1 The following steps describe the steps taken for each refueling operation. Refer to Figure 1 for valve numbers and other equipment described.

4.1.1 At the point where the vapor return line from the dispensing nozzle, connect the vapor return hose to valve 1. This valve and others in the sampling line should present no greater restriction to flow than the return hose.

4.1.2 Connect a 1½ inch diameter hose from valve 4 to the underground vapor return line connection.

4.1.3 Close tightly valves 1 and 4 and open valves 2 and 3. Evacuate the plastic bag with the vacuum pump. Record the dry gas meter reading when the bag is collapsed.

4.1.4 Close valves 2 and 3, open valves 1 and 4 and begin the refueling operation.

4.1.5 After shut-off of the dispensing pump, close valves 1 and 4, open valves 2 and 3, and evacuate the bag to collapse. During evacuation record volume meter temperature and pressure. Record the final volume meter reading when the evacuation is complete.

4.1.6 Repeat steps 4.1.4 and 4.1.5 for each vehicle refueling operation.

5. *Calculations.*

5.1 Nomenclature.

V_i = Initial dry gas meter reading (ft^3).
V_f = Final dry gas meter reading (ft^3).
T_m = Meter temperature during evacuation (°F).
P_a = Atmospheric pressure (in. Hg).

5.2 Calculate the standard volume of returned vapor (@ 70° F and 29.92 in. Hg).

$$V_s = 17.71(V_f - V_i)\left(\frac{P_a}{T_m + 460}\right)$$

Note: If the meter pressure during evacuation of the bag is substantially different from atmospheric pressure, P_a, substitute the proper valve.

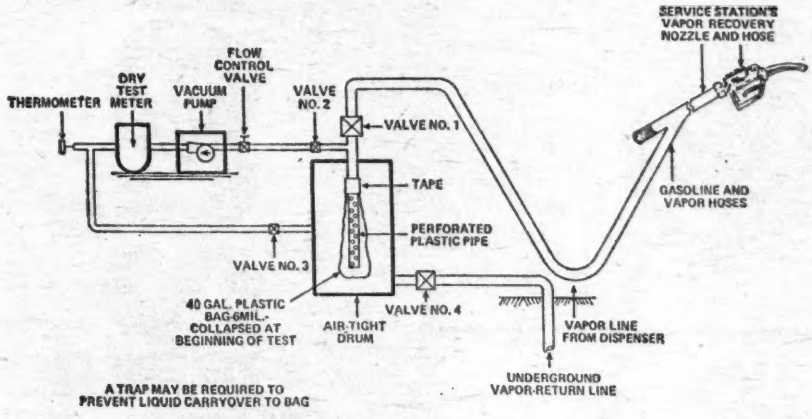


FIGURE 1. EQUIPMENT FOR MEASURING VOLUME.

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